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by

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ABSTRACT

The strain response of metal plates during welding is discussed and current state-of-the-art efforts to analyze the phenomena are reviewed. Mechanical and physical temperature dependent properties; transient strain and temperature distribution data obtained from experiments on 6061 aluminum alloy in the T651 condition; and a data reduction computer program are presented. The experiments were designed to look at the macroscopic effects of welding upon heat treatable age hardened alloys while at the same time approximating ship structural weldments.

The transient strain response was found to be predominantly longitudinal but transverse strains were significant in the region of the welding arc. It was also found that residual strains correlated reasonably between similar experiments with a variation of the second stress deviator tensor invariant J_2 representing the "state of stress" rather than by individual strain components.

Several recommendations are made concerning continued experimental investigation aimed at further development of the National Aeronautics and Space Adminstration programs.

THESIS SUPERVISOR: Koichi Masubuchi

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To Professor Koichi Masubuchi, who advised and guided me for the past three years as a professor and a friend, I am forever indebted.

Lastly, I acknowledge those all-encompassing laws governing experimental efforts identified with Murphy and wish to add another corollary: "If you don't understand the problem then you in all probability are part of it." My stay at MIT has directed me more towards understanding, but there will always be a part of us in every problem we deal with.

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I: INTRODUCTION

A. Background:

The phenomenon of thermal stresses and strains resulting from welding processes lead to difficulties in the fabrication of structures. Non-uniform temperature distribution leads to residual stresses which in turn provide problems from stress corrosion, buckling, brittle fracture, fatigue strength, and distortion. Depending upon the type of material being welded, any or all of the above problems may be important considerations in the structure's design and its service performance (1). All contribute to the reliability of the basic structure (2, pp. 2). Masubuchi (2 - 5), Klein and Masubuchi (6), and Klein (7) provide interpretive reports which review the particulars of each of the above phenomena for aluminum and steel as well as comprehensive reviews of the literature. Almost all of the previous studies refer to residual stresses and distortion and only recently has much attention been given to the actual thermal stresses during welding. This is due to the complexity of the problem characterized by large temperature changes in small areas near the welding arc with its resulting non-elastic deformation, temperature dependency of the material properties and/or phase transformations, and complex boundary conditions resulting from conditions of geometry and multi-pass welding (3, pp. 2, 3).

B. Thermal Stresses During Welding, Residual Stresses and Distortion:

In order to study the effects of residual stresses and distortion performance of welded structures, it is first necessary to understand the relative magnitude and distribution of residual stresses and distortion in weldments. The mechanism by which thermal stresses and strains are developed in welded plates is best described by Masubuchi (8,3, pp. 4-6) and is repeated here:

Figure 1 shows schematically changes of temperature and stresses during welding. A bead-on-plate weld is being made along the x-axis. The welding arc, which is moving at a speed, v, is presently located at the origin, O, as shown in Figure 1a.

Figure 1b shows temperature distribution along several cross section. Along Section A-A, which is ahead of the welding arc, the temperature change due to welding, ΔT, is almost zero. Along Section B-B, which crosses the welding arc, the temperature distribution is very steep. Along Section C-C, which is some distance behind the welding arc, the distribution of temperature change is as shown in Figure 1b-3. Along Section D-D, which is very far from the welding arc, the temperature change due to welding again diminishes.

Figure 1c shows the distribution of stresses along these sections in the x-direction, σ_x. Stress in the

y-direction, σ_y, and shearing stress, τ_{xy}, also exists in a two-dimensional stress field.*

Along Section A-A, thermal stresses due to welding are almost zero. The stress distribution along Section B-B is shown in Figure 1c-2. Stresses in regions underneath the welding arc are close to zero, because molten metal does not support loads. Stresses in regions somewhat away from the arc are compressive, because the expansion of these areas is restrained by surrounding metal that is at lower temperatures. Since the temperatures of these areas are quite high and the yield strength of the material is low, stresses in these areas are as high as the yield strength of material at corresponding temperatures. The magnitude of compressive stress passes through a maximum with increasing distance from the weld or with decreasing temperature. However, stresses in areas away from the weld are tensile and balance with compressive stresses in areas near the weld. In other words,

$$\int \sigma_x \cdot dY = 0 \qquad (1)$$

across Section B-B.** Thus, the stress distribution along

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* In general three-dimensional stress field, six stress components, σ_x, σ_y, σ_z, τ_{xy}, τ_{zy}, τ_{zx} exist.

** Equation (1) neglects the effect of σ_y and τ_{xy} on the equilibrium condition.

Section B-B is as shown in Figure 1c-2.

Stresses are distributed along Section C-C as shown in Figure 1c-3. Since the weld metal and base metal regions near the weld have cooled, they try to shrink causing tensile stresses in regions close to the weld. As the distance from the weld increases, the stresses first change to compressive and then become tensile.

Figure 1c-4 shows the stress distribution along Section D-D. High tensile stresses are produced in regions near the weld, while compressive stresses are produced in regions away from the weld. The distribution of residual stresses that remain after welding is completed as is shown in the figure.

The cross-hatched area, M-M, in Figure 1a shows the region where plastic deformation occurs during the welding thermal cycle. The ellipse near the origin O indicates the region where the metal is melted. The region outside the cross-hatched area remains elastic during the entire welding thermal cycle.

As shown in Figure 1, thermal stresses during welding are produced by a complex mechanism which involves plastic deformation at a wide range of temperatures from room temperature up to the melting temperature. Because of the difficulty in analyzing plastic deformation, especially at elevated temperatures, mathematical analyses were limited

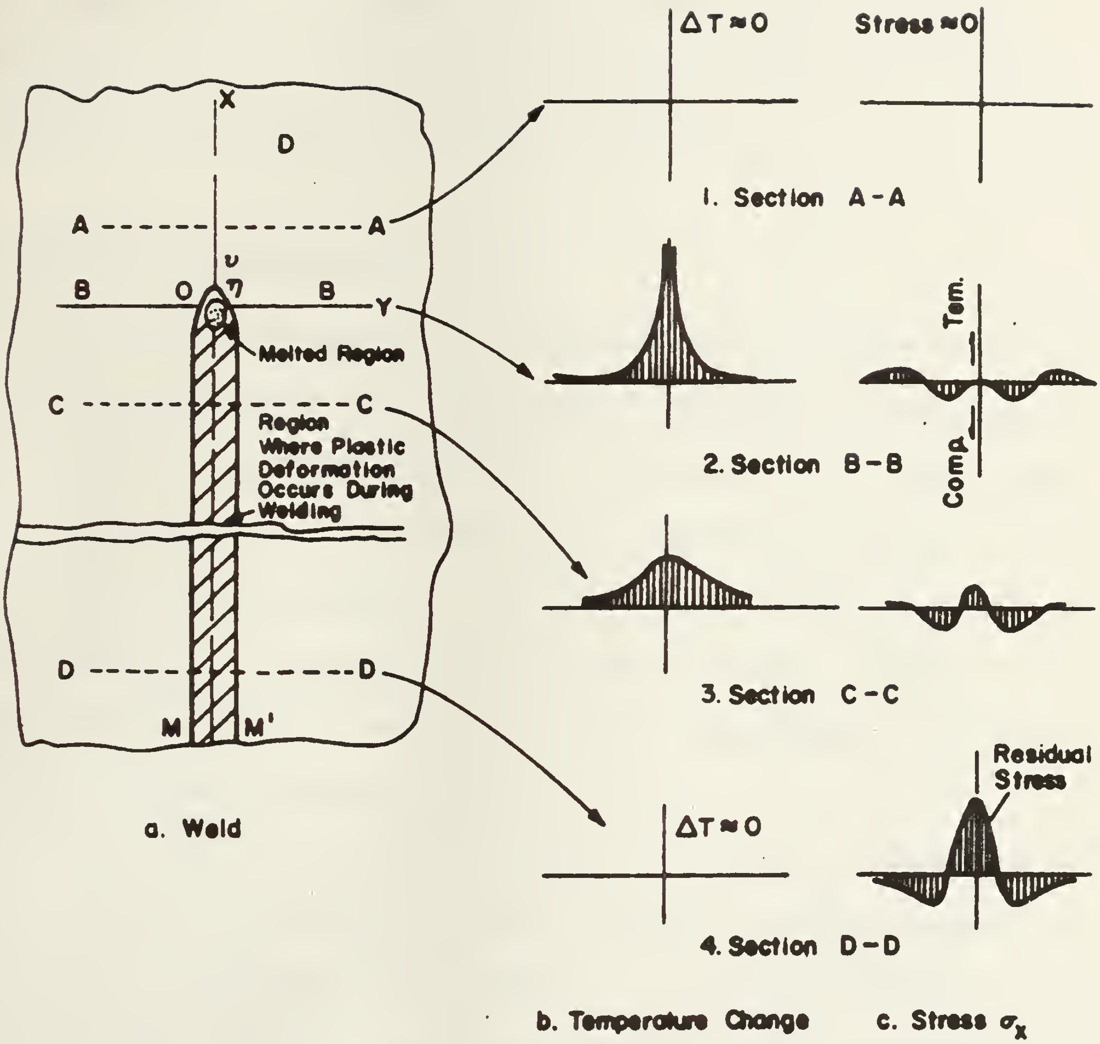

Figure 1 Schematic Representation of Changes of Temperature and Stresses During Welding (3,8).

for very simple cases such as spot welding.

However, on the basis of recent developments in computer technology, it appears that a technological breakthrough as far as the analysis of thermal stresses during welding are concerned is not too far away.

C. Previous Investigations:

The closest approach to a breakthrough to date has been the one-dimensional strip theory approach first presented by Tall (9) and extended by Masubuchi and associates at Battelle Memorial Institute (10) and Massachusetts Institute of Technology (7, 11, 12) under the support of NASA's George C. Marshall Space Flight Center. These studies have been reviewed in detail in references (3- 6) and will not be repeated here.

A great deal of effort in the last several years has been devoted to developing finite element programs which will extend one-dimensional analysis to two and three dimensions (13 - 20). Nearly all have met some qualitative success but in general, quantitative results have been lacking. The finite element method utilizes an approximate model to derive a set of equations which is then solved exactly. The flexibility of the finite element method will

allow the extension of the flat plate problem into more complex and real life geometries. It provides a complete strain picture, including longitudinal, transverse, and shear strains. It has the capability to model the restraint conditions in the actual structure and weld. Its greatest drawback is high expense from considerable computer time for large degree of freedom problems and the post analysis of the vast quantities of data the technique generates. Interactive graphics will greatly aid this latter problem in the future.

Masubuchi and Iwaki (13) and Masubuchi and Andrews (14) coupled the elastic-plastic analysis developed by Wang (15) with the thermal loading calculations for moving heat sources previously utilized by the one-dimensional programs. Reference (13) was qualitative and reference (14) provided some quantitative results with course meshes but appeared to have transition element instability when a smaller mesh was utilized. In this situation, an element which reaches yield stress is considered a transition element. However, in the next iteration, the equivalent stress from that element drops below yield and the element becomes elastic again. The whole situation jumps between the two sets of values. In order to overcome this difficulty, a scheme was devised to quarter the time step in which this instability occurred. This worked for a large number of cases

but not all cases. Sometimes increasing the time step also eliminated the instability. Reference (10) may offer a way to correct this problem. Yamada (17) seems to have met with more success dealing with thermal stresses due to rapid heating by controlling the number of elements which yield.

Hibbit and Marcal (18) offer the most analytic of the approaches to date. Their model treats the weld process as a thermo-mechanical problem. A finite element formulation derived from the uncoupled thermal and mechanical energy balances forms the basis of the model. It attempts to deal with material non-linearity due to temperature dependence of thermal properties and in the fusion problem where material phase change is accompanied by a latent heat effect. It includes radiation as a cooldown mechanism and finite strain effects during isothermal loading. However, there was little agreement with experimentally measured residual stresses and they concluded that their finite element model did not include significant material behavior.

Shinn (19) approaches the two-dimensional distortion of a panel structure due to welding with the assumption of elastic deformation during the welding process. Computations were carried out using the one-dimensional experimental values of unconstrained angular changes along the welded edge and its equivalent constrained welding

moment as an input to the computer program. The results were not completely successful because of the elastic assumption and the questionable accuracy of the experimental data input into the program. It is of the opinion of this author that this technique, on the basis of current technology, will provide the most fruitful results in the immediate future in terms of financial and manpower investments. The basic welding problem is highly non-linear and may be too complex to solve in a completely analytical form. A purely empirical approach does not appear very fruitful, either. It is not a simple task to determine thermal stresses in small regions heated to high temperatures. Without proper analysis, it would be difficult to adequately interpret experimental data.

The empirical-analytic technique, however, is only as good as experimental data provided. At present, material and physical properties at the range of temperature from room to melting, even for the most common of structural materials, are sorely lacking in the literature. More effort must be expended in providing this critical information. The approximations utilized in the interim will be the controlling feature of this computational technique.

D. Aim and Purpose of the Present Study:

Muraki and Masubuchi are presently developing a new elasto-plastic finite element computer program at Massachusetts Institute of Technology along the lines described by Yamada (17) with temperature distribution adopted from reference (20). It is the purpose of this report to provide experimental data on a heat treatable tempered aluminum alloy to verify this program. Electric resistance thermocouples, three element strain gage rosetts, single element strain gages, and an extensioneter will be utilized to obtain transient and residual strain and displacement data in the center and near the edge of 30x18 inch panels for an automatic GMA welding process. Experiments will be performed for bead-on-plate and butt welding processes under similar heat inputs to verify:

1. that experiments may be duplicated under reasonably similar conditions to give repeatable results;

2. to compare butt and bead-on-plate welds for similarities and differences;

3. to compare strains in both top and bottom of the plates to study the importance of bending strains as compared with transverse and longitudinal strains;

4. to observe transient principal strain magnitudes and directions;

5. to measure residual stress/strain distributions

in the longitudinal and transverse directions;

6. to measure the deflection of the two half plates in a butt welding process under tack welded conditions;

7. to present longitudinal and transverse strains for computational technique verification, and;

8. to collect and present in usable form available physical and mechanical temperature dependent data for use in the computer analysis.

Standard strain gages will be utilized which may not exceed 400°F. Since the material properties in the heat affected zone (HAZ) are not fully known or understood and the high temperature strain gages have proven unreliable (6, 7) in part because of temperature compensation data and in part by the lack of material properties data within the HAZ, strain measurements will be beyond the HAZ.

II: MATERIAL BEHAVIOR

A. General:

A new finite element program to study residual stresses and metal movement is presently being developed by M.I.T.'s Department of Ocean Engineering concurrent with this thesis. Since an attempt is being made here to provide material properties for and consistent with this new program, a brief and simple formulation of the tangent stiffness technique, incremental stress strain relationship, and thermal loading terms is provided for the sole purpose of demonstrating the importance of temperature dependency. Then, material properties consistent with this formulation are presented for 6061 aluminum alloy in the T6 and T651 condition, the material utilized for the experiments presented in Chapter III.

B. Mathematical Formulation:

The most common finite element approach to plasticity problems in welding has been the Tangent Stiffness Approach. The problem is first solved elastically for the general loads. Then the elastic limit loads are determined by scaling down the given loads until the element with the maximum equivalent stress is just reached. The differences between the given loads and the elastic limit loads are then

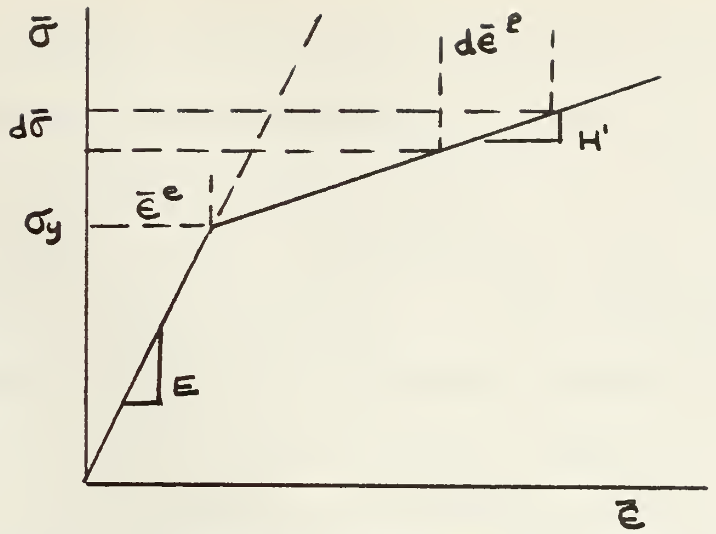

Figure 2: Equivalent Stress and Strain (14,pp 20)

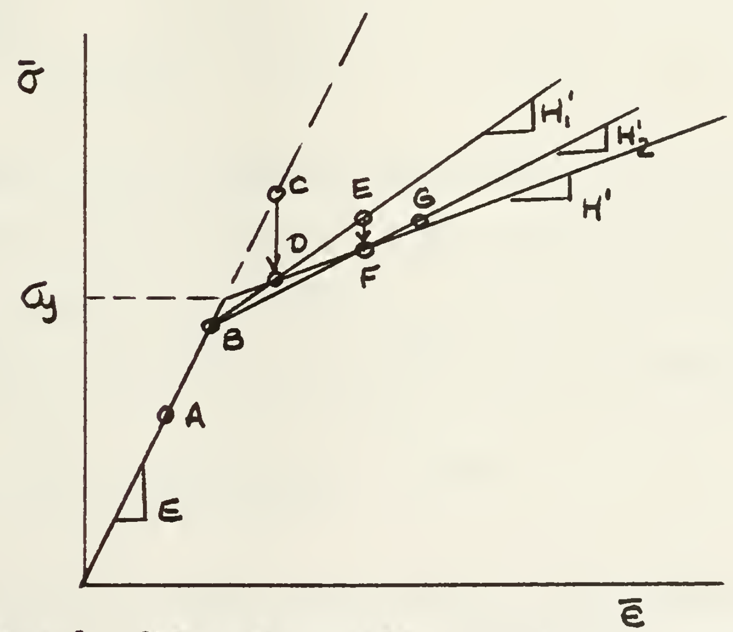

Figure 3: Iteration Process to Bring Back the Stress Point on to the $\bar{\sigma}$-$\bar{\epsilon}$ curve with H'. The element in the transition region starts out at point B as elastic. The elastic increment BC of the element for the prescribed load increment dP is first calculated. The stress point corresponding to C should be D on the stress-strain curve. Using the modulus corresponding to BD, the increment BF for dP is next calculated. This process may be repeated until the solution converges (17, pp 300,303).

divided into a predetermined number of loading increments. The problem is then solved including plasticity for each element. When an element becomes plastic, the tangent stiffness approach is used to determine an effective elasto-plastic stiffness for that element. In this approach, the Prandtl-Reuss relation and the plastic modulus are combined with the elastic stress-strain relations to produce an incremental stress-strain relation which includes the effects of plasticity. These incremental relations depend upon the instantaneous stress levels in each element (14, pp. 4 - 5).

In general,

$$\underset{\sim}{d\sigma} = \underset{\sim}{E_t} \; \underset{\sim}{d\varepsilon} \tag{2}$$

where $\underset{\sim}{E_t}$ is the tangent modulus coefficient. $\underset{\sim}{E_t}$ has an elastic term and a plastic term. The plastic term is zero if no yielding takes place. Then, $\underset{\sim}{E_t}$ may be used to establish the tangent stiffness array $\underset{\sim}{K_n}$ for each element,

$$\underset{\sim}{K_n} = \int_{\text{Volume}} \underset{\sim}{B_n^t} \; \underset{\sim}{E_t} \; \underset{\sim}{B_n} \; d\,(\text{Volume}) \tag{3}$$

where $\underset{\sim}{B_n}$ defines the strain displacement relationships. Thus, where loading is applied in increments, the structure stiffness array may be found at each stage of loading by evaluating each element's tangent stiffness (21, pp. 12 - 13).

The incremental pseudo-thermal loading term likewise

becomes

$$\underset{\sim}{dP}_n = \int_{Volume} \underset{\sim}{B}_n^t \, \underset{\sim}{E}_t \, \underset{\sim}{d\varepsilon}_t \, d\,(Volume) \tag{4}$$

where $\underset{\sim}{d\varepsilon}_t$ is the thermal strain caused by the welding process. Summed over the entire structure, one obtains:

$$\underset{\sim}{K}\,\underset{\sim}{dU} = \underset{\sim}{dP} \tag{5}$$

$$\underset{\sim}{dU} = \underset{\sim}{K}^{-1}\,\underset{\sim}{dP} \tag{6}$$

$$\underset{\sim}{d\varepsilon} = \underset{\sim}{B}^t\,\underset{\sim}{dU} \tag{7}$$

$$\underset{\sim}{d\sigma} = \underset{\sim}{E}_t\,\underset{\sim}{B}^t\,\underset{\sim}{dU} \tag{8}$$

To determine the tangent modulus coefficient related to equation (2), one must consider the following relations:*

Prandtl-Reuss Flow Rule:

$$\underset{\sim}{d\varepsilon}^p = \frac{\partial\bar{\sigma}}{\underset{\sim}{\partial\sigma}}\,d\bar{\varepsilon}^p \tag{9}$$

Yielding Surface Behavior:

$$d\bar{\sigma} = \frac{\partial\bar{\sigma}}{\underset{\sim}{\partial\sigma}}^T\,\underset{\sim}{d\sigma} \tag{10}$$

Material Behavior:

$$\bar{\sigma} = \bar{\sigma}_o + E_t^p\,\bar{\varepsilon}_p = \bar{\sigma}_o + H'\,\bar{\varepsilon}_p \tag{11}$$

$$d\bar{\sigma} = E_t^p\,d\bar{\varepsilon}_p = H'\,d\bar{\varepsilon}_p \tag{12}$$

Utilizing equations (9) - (12) and recalling that

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* The p and e superscripts refer to plastic and elastic respectively.

$$\underset{\sim}{d\sigma} = \underset{\sim}{D}\underset{\sim}{d\varepsilon}^{e} = \underset{\sim}{D}\,(\underset{\sim}{d\varepsilon} - \underset{\sim}{d\varepsilon}^{p}) \tag{13}$$

where $\underset{\sim}{d\varepsilon}$ is the total incremental strain and $\underset{\sim}{D}$ is given in Equation (24) for the plane stress situation, one arrives at the following relationship:

$$\underset{\sim}{d\sigma} = \left\{ \underset{\sim}{D} - \underset{\sim}{D}\,\frac{\partial\bar{\sigma}}{\partial\underset{\sim}{\sigma}} \left[\frac{\dfrac{\partial\bar{\sigma}}{\partial\underset{\sim}{\sigma}}^{T}\underset{\sim}{D}}{H^{1} + \dfrac{\partial\bar{\sigma}}{\partial\underset{\sim}{\sigma}}^{T}\underset{\sim}{D}\,\dfrac{\partial\bar{\sigma}}{\partial\underset{\sim}{\sigma}}} \right] \right\} \underset{\sim}{d\varepsilon} \tag{14}$$

This reduces to equation (2) where the quantity in $\{\ \}$ is the tangent modulus coefficient. This is consistent with reference (17, pp. 310).

If we assume plane stress conditions and consider the equivalent stress for Von Mises' isotropic material,

$$\bar{\sigma}^{2} = \sigma_{x}^{2} - \sigma_{x}\sigma_{y} + \sigma_{y}^{2} + 3\tau_{xy}^{2} \tag{15}$$

Differentiating,

$$d\bar{\sigma} = \frac{1}{2\bar{\sigma}}\left[(2\sigma_{x} - \sigma_{y})\,d\sigma_{x} + (2\sigma_{y} - \sigma_{x})\,d\sigma_{y} + 6\tau_{xy}d\tau_{xy}\right] \tag{16}$$

This may be rewritten in matrix form as

$$d\bar{\sigma} = \frac{1}{\bar{\sigma}}\,\underset{\sim}{\sigma}^{T}\begin{bmatrix} 1 & -\frac{1}{2} & 0 \\ -\frac{1}{2} & 1 & 0 \\ 0 & 0 & 3 \end{bmatrix}\underset{\sim}{d\sigma} \tag{17}$$

or

$$d\bar{\sigma} = \frac{1}{\bar{\sigma}}\,\underset{\sim}{\sigma}^{T}\,\underset{\sim}{F}\,\underset{\sim}{d\sigma} \tag{18}$$

where

$$\underset{\sim}{\sigma} = \begin{bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{bmatrix} \quad (19) \qquad \underset{\sim}{d\sigma} = \begin{bmatrix} d\sigma_x \\ d\sigma_y \\ d\tau_{xy} \end{bmatrix} \quad (20)$$

Comparing equations (10) and (18), we see that

$$\frac{\partial\bar{\sigma}}{\partial\underset{\sim}{\sigma}}^T = \frac{1}{\bar{\sigma}}\underset{\sim}{\sigma}^T\underset{\sim}{F} \tag{21}$$

Transposing,

$$\frac{\partial\bar{\sigma}}{\partial\underset{\sim}{\sigma}} = \frac{1}{\bar{\sigma}}\underset{\sim}{F}^T\underset{\sim}{\sigma} = \frac{1}{\bar{\sigma}}\underset{\sim}{F}\,\underset{\sim}{\sigma} \tag{22}$$

Substituting the previous relationships into equation (14) we arrive at

$$\underset{\sim}{d\sigma} = \left[\underset{\sim}{D} - \frac{\underset{\sim}{D}\,\underset{\sim}{F}\,\underset{\sim}{\sigma}\;\underset{\sim}{\sigma}^T\,\underset{\sim}{F}\,\underset{\sim}{D}}{\bar{\sigma}^2 H' + \underset{\sim}{\sigma}^T\,\underset{\sim}{F}\,\underset{\sim}{D}\,\underset{\sim}{F}\,\underset{\sim}{\sigma}}\right]\underset{\sim}{d\varepsilon} \tag{23}$$

for a two dimensional, plane stress, isotropic case, with the Von Mises' yield criterion where

$$\underset{\sim}{D} = \frac{E}{1 - \nu^2}\begin{bmatrix} 1 & \nu & 0 \\ 0 & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix} \tag{24}$$

$$\underset{\sim}{F} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 \\ -\frac{1}{2} & 1 & 0 \\ 0 & 0 & 3 \end{bmatrix} \tag{25}$$

$$\bar{\sigma}^2 = \sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau_{xy}^2 \tag{15}$$

Equation (23) is but a simple example of the more complex general case. The important point to note here is that E, $\bar{\sigma}$, and H' are functions of temperature and this makes quite complex even the most simple of welding problem examples.

In the previous study at the Massachusetts Institute of Technology, Andrews (14, pp. 25) assumed the simplest model possible for the nodal force matrix, i.e., that of a constant temperature of each element. In this case, the nodal force matrix for each increment becomes

$$d\underset{\sim}{P}_n = \int_{Volume} (\underset{\sim}{B}_n^T \underset{\sim}{E}_t \, d\underset{\sim}{\varepsilon}_t) \, d\,(Volume) \qquad (4)$$

$$d\underset{\sim}{\varepsilon}_t = \Delta T \begin{bmatrix} \alpha \\ \alpha \\ 0 \end{bmatrix}$$

where

ΔT = average temperature change of element

α = coefficient of linear thermal expansion

If the element in question is plastic, the tangent stiffness matrix is used. Masubuchi and Iwaki (13, pp. 9) assumed a much more complex loading function which accounted for the equivalent nodal forces due to the dependency of the coefficient of thermal expansion and Young's modulus on temperature. The plastic terms additionally took the temperature dependency of the yield surface into account. Yielding is complex. It can occur during the heating stage

and also in the subsequent cooling stage since some elements can be stressed to their yield point in the reverse direction. Yamada (17, pp. 298) assumed the same simplified type of expression as equation (4) in his study of thermal stresses due to rapid heating. As in the case of the incremental stress-strain relation, the important point to note is that in varying degrees of difficulty, the loading term is dependent upon E, $\overline{\sigma}$, and α which are in turn dependent upon temperature.

The temperature distribution, uncoupled from the mechanical problem just described, may be approximated by classical, finite difference, or finite element techniques (9-11, 13, 14, 18, 20, 24-30). In terms of the conductivity tensor, κ, the general representation of the anisotropic heterogeneous continuum is

$$\rho c \frac{dT}{dt} = \nabla \cdot (\kappa \cdot \nabla T) + U''' \tag{25}$$

where ρ is the density, c is the specific heat, κ is the thermal conductivity, and U''' is the heat generation per unit volume (23, pp. 29, 44-45). Fourier's law applied to the boundary conditions provides

$$q = -\kappa \cdot \nabla T \tag{26}$$

where q is the heat flux normal to the boundary surface. If the continuum is isotropic, these vector equations reduce to the familiar

$$\rho c \frac{dT}{dt} = \nabla \cdot (\kappa \nabla T) + U''' \qquad (27)$$

$$q = -\kappa \nabla T \qquad (28)$$

Equation (27) may be reduced to

$$\rho c \frac{dT}{dt} = \nabla \kappa \cdot \nabla T + \kappa \nabla^2 T + U''' \qquad (29)$$

If κ is a function of space only, equation (29) is linear. On the other hand, where κ depends on temperature alone,

equation (29) may be modified to:

$$\rho c \frac{dT}{dt} = \frac{dU}{dT} (\nabla T)^2 + \kappa \nabla^2 T + U''' \tag{30}$$

which is nonlinear. For homogeneous isotropic continua κ is constant and equation (29) reduces to

$$\frac{dT}{dt} = a\nabla^2 T + \frac{U'''}{\rho c} \tag{31}$$

where a is the thermal diffusivity. Since ρ, c, and κ are functions of temperature, the welding problem becomes highly nonlinear. Coupled with phase changes, this problem becomes even more complex.

C. Material Properties:

As discussed in Section B, tabulation of the material properties as a function of temperature is of prime importance. This information is difficult to obtain and often simply is not available. In this experimental work, alloy 6061 in the T651 Condition is utilized. It is one of the most versatile of the wrought, heat treatable aluminum alloys. An understanding of the behavior of this common, relatively inexpensive material during welding and heat treating may also contribute to the understanding of the behavior of quenched and tempered steels such as HY-80 and HY-130 currently in use today. 6061 is readily welded by all methods and has excellent weldability characteristics.

The plate used in this experiment has a Federal Specification of QQA-250/11.

1. <u>Composition</u> (31, Code 3206, pp. 1)

	Percent	
	Min.	Max.
Chromium	0.15	0.35
Copper	0.15	0.40
Iron	-	0.7
Magnesium	0.8	1.2
Manganese	-	0.15
Silicon	0.40	0.8
Titanium	-	0.15
Zinc	-	0.25
Other impurities		
each	-	0.05
total	-	0.15
Aluminum	Balance	

TABLE 1: Composition of 6061 Aluminum Alloy

2. <u>Heat Treatment</u> (31, Code 3206, pp. 1)

<u>Annealed</u> (0 Condition): Heat to 775°F for 2 to 6 hours, cool at 50°F per hour maximum to 500°F. The rate of subsequent cooling is unimportant.

<u>T4 Condition</u>: Solution heat treat to 970°F, water quench, and naturally age at room temperature to a substantially stable condition.

<u>T6 Condition</u>: Solution heat treat to 970°F, water quench, artificially age by precipitation heat treatment at 320°F for 16 to 20 hours or 350°F 6 to 10 hours and

air cool.

T651/T451 Condition: Same as the T6/T4 Condition followed by a 1 1/2 to 3 percent permanent set stretch stress relief prior to any precipitation heat treatment.

The soft, as quenched 0 Condition can be preserved by refrigeration in order to minimize springback and increase the general ease of forming operations. Maximum holding times which will preserve the formability of this condition are shown in Table 2 (31, Code 3206, pp. 3).

Temperature °F	R.T.	32	20
Time	2 hours	2 days	7 days +

TABLE 2: Holding Times for 6061 in 0 Condition

3. Specified Mechanical Properties (31, Code 3206, pp. 2)

TABLE 3: Specified Mechanical Properties.

Condition	0	T4, T451	T6, T651
Thickness - in.	0.250	0.250	0.250
Ultimate Stress in Tension min. ksi	22	30	42
0.2% Offset Yield Stress in Tension min - ksi	12	16	35
Ultimate Elongation 2 inch min - %	18	16 - 18	6 - 10
Ultimate Shear Stress Typical - ksi	12	24	30

4. Mechanical Properties:

In welding aluminum, it must be remembered that the metal in the area of the weld will be in an annealed condition after welding. There will be a corresponding loss of strength unless heat treatment is done after welding. Welding does not always reduce the strength of the heat treated alloys to that of the fully annealed condition because there is some air quenching of the metal as it cools (32, pp. 6.33). Table 4 (32, pp. 6.34) demonstrates this effect for the type of filler metal utilized in this experiment.

Filler Wire	Specified minimum tensile strength of base plate in ksi.	Average tensile strength across weld in ksi.	Average bend free elongation %
	Not heat treated after welding		
4043	42.0	27.2	16.0
	Heat treated and aged after welding		
4043	42.0	43.5	11.0

TABLE 4: Strength and Ductility of Welded Butt Joints in Aluminum (TIG and GMA with argon).

Brungraber and Nelson (33) report that 6061 alloy may be heated up to 550°F by butt welding without appreciably affecting the mechanical properties of the base plate. They further report that for thicknesses less than one

inch, the distance from the center of the weld to the edge of the heat affected zone (HAZ) may be predicted as:

$$b_h = 0.6t + 0.00059 \frac{EI}{Vt} \tag{32}$$

where E has units of volts, I amperes, V inches per minute, and t (thickness) inches. As an example, for $E = 20.$, $I = 240.$, $t = .25$ and $V = 32.16$, $EI/Vt = 597$ watt - min/in^2, and $b_h = .50$ inch. The extent of the fusion zone may depend somewhat on the parameter EI/Vt but it is governed primarily by the thickness t of the plate and the geometry of the edge preparation.

Figures 4 through 10 provide mechanical properties at both room temperature and elevated temperatures. Figure 4 provides typical tension and compression stress strain curves for the experimental plate. Figure 5 provides the average stress strain curves for varying temperatures from room temperature to 700°F based on a half hour exposure to the temperature in question. This may or may not be a valid approximation for the welding problem, but it is the only information currently available. Figure 6 shows the effect of this temperature on the 0.2% offset yield stress. This may be approximated as the cubic polynomial given in Table 5. Figure 7 demonstrates the effect of the half hour soak temperature on Young's

modulus. This curve was generated from Figure 5. Its cubic approximation is listed in Table 5.

Figure 8 shows the room temperature tangent modulus at various stress levels. Its straight line approximation is

$$H' \times 10^{-3}(\text{ksi}) = 0.917\sigma\ (\text{ksi}) + 38.064 \tag{33}$$

The highest stress level shown on this figure is 40.7 ksi. This equates to $H' = 0.746 \times 10^{+3}$ ksi and may be utilized effectively for constant strain hardening. Figure 9 represents an estimate of the temperature effects on the tangent modulus. If one assumes that

$$H'(T°F) \propto E(T°F) \tag{34}$$

then

$$H'(T°F) = \frac{H'(R.T.) \times E(T°F)}{E(R.T.)} \tag{35}$$

Masubuchi and Andrews (11) define the constant strain hardening parameter for their one-dimensional computer program as

$$H' = mE \tag{36}$$

From the above equations,

$$m = H'/E = H'(T°F)/E(T°F) = 0.0742 \tag{37}$$

This is the first such value ever determined for their

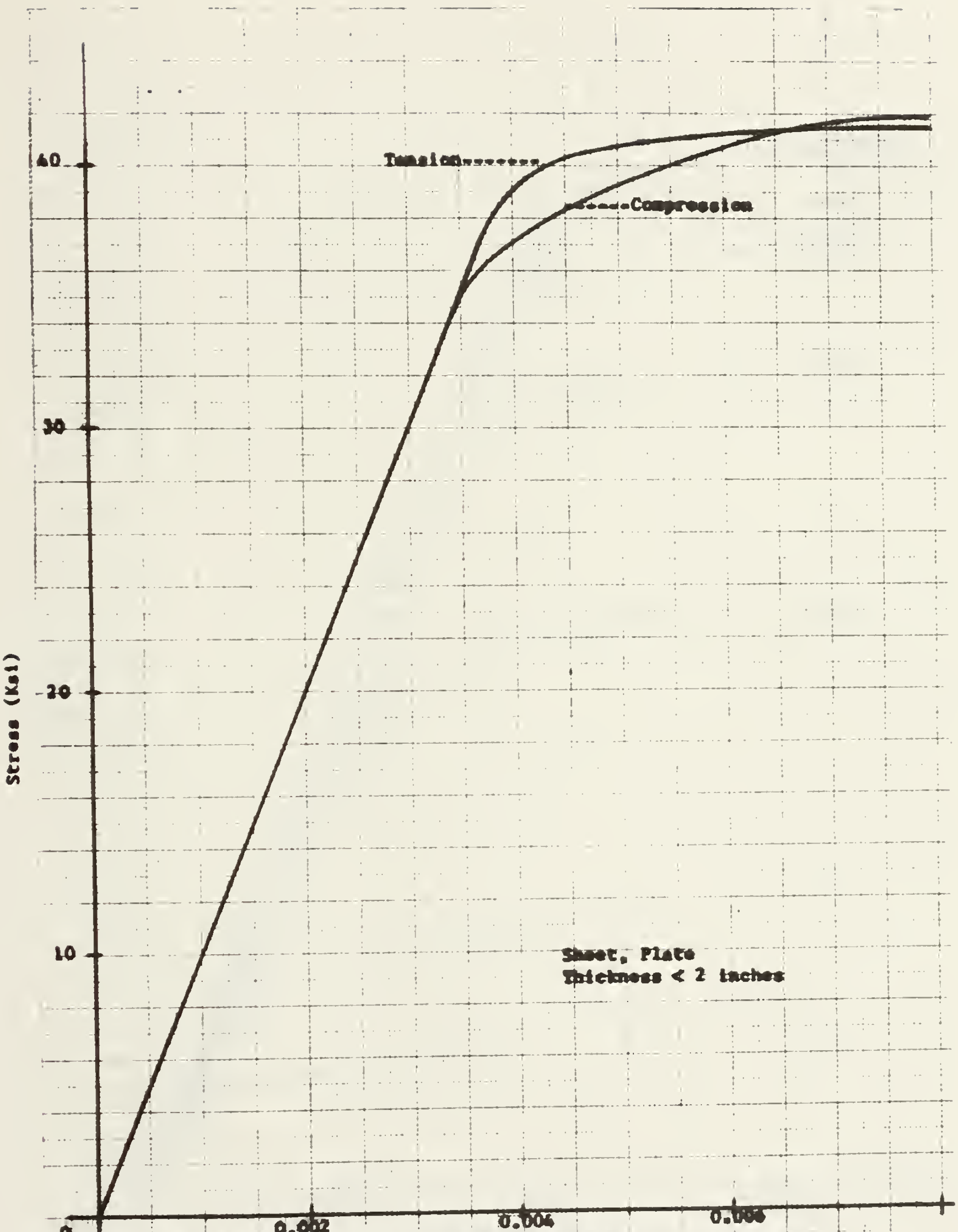


Figure 4: Room Temperature Tension and Compression Stress Strain Curves for 6061 in the T6 Condition (31).

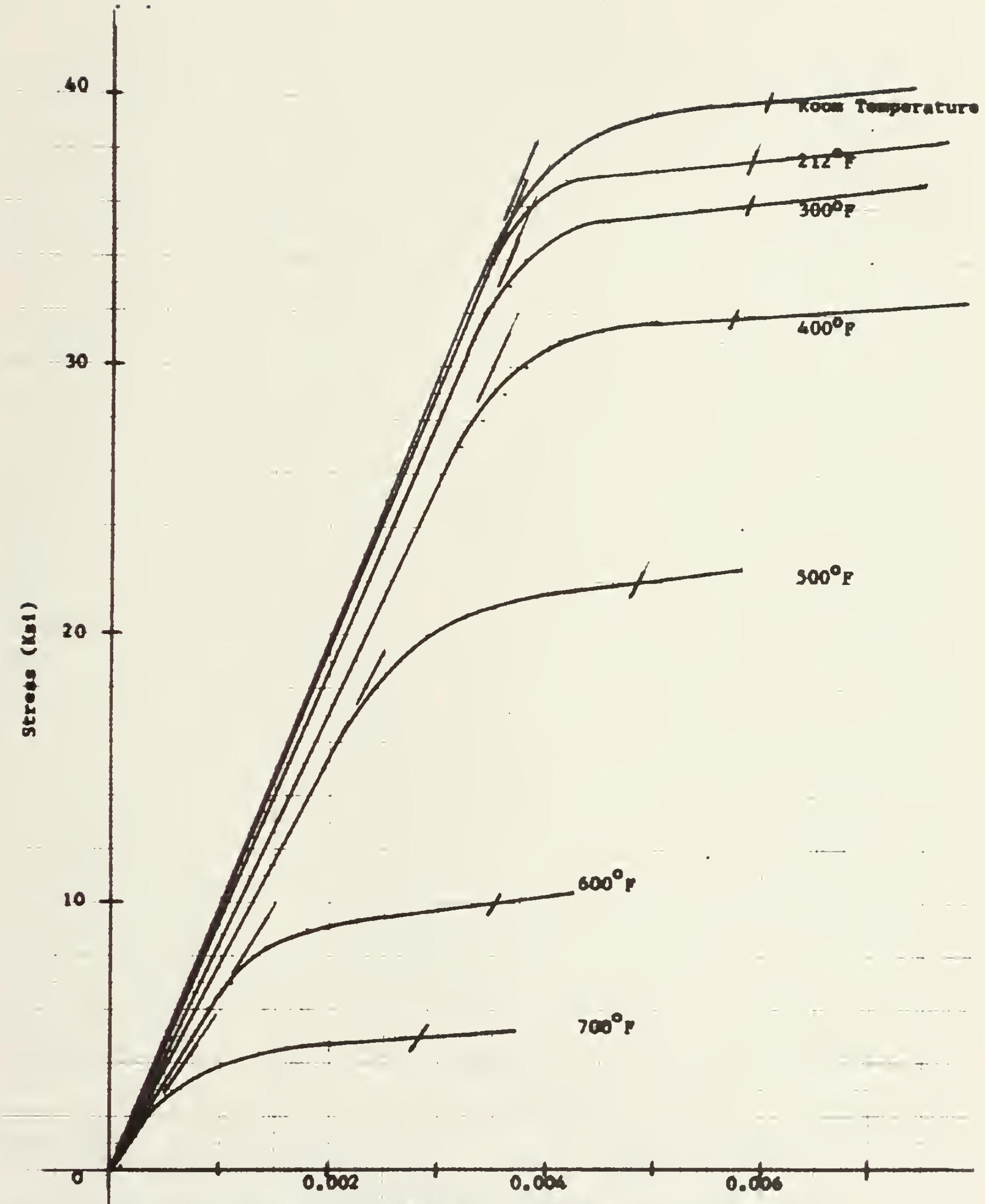


Figure 5: Stress Strain Curves for 6061 in T6 Condition after 0.5 Hour at Temperature (31,32)

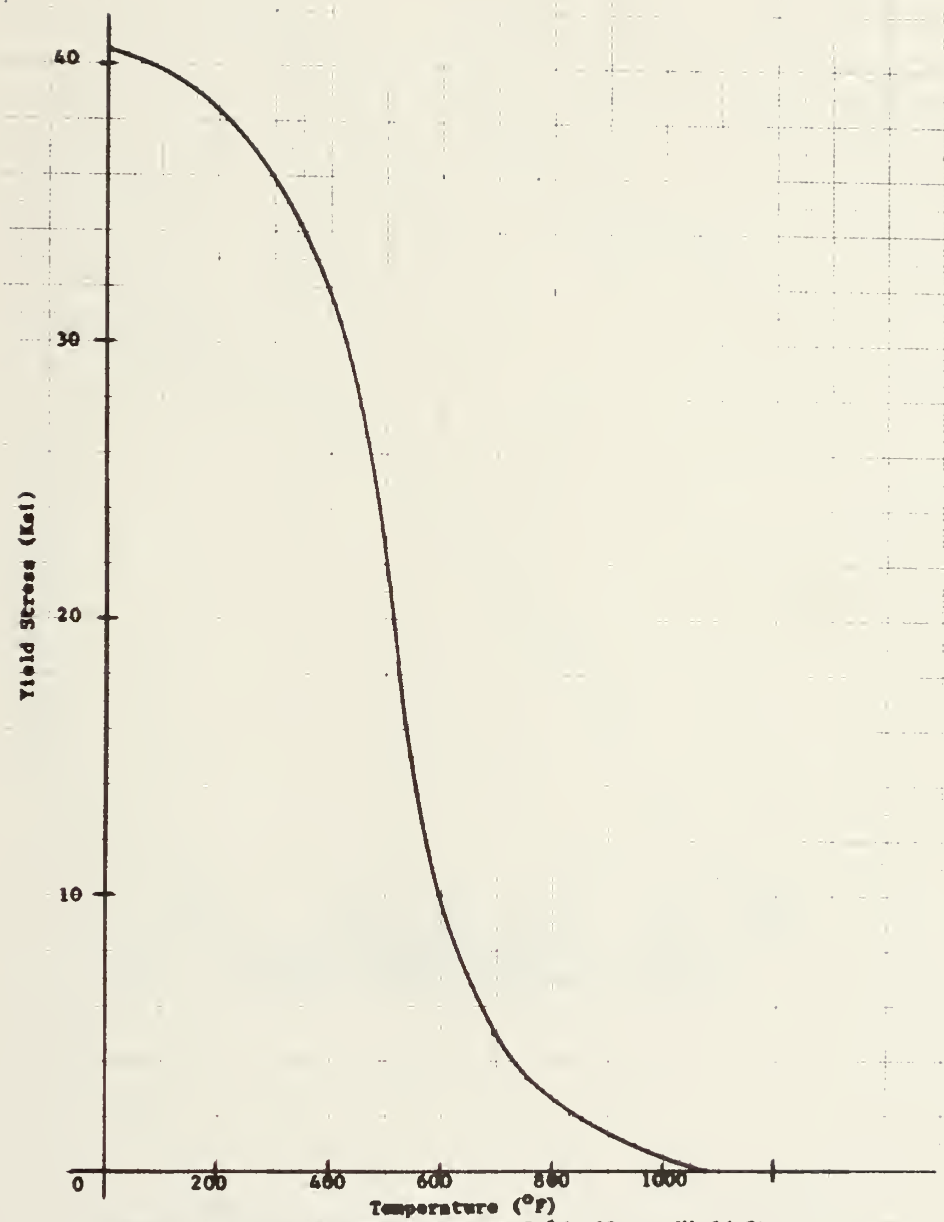


Figure 6: Effect of Temperature on 0.2% Off-set Yield Stress for 6061 in T6 Condition. (31,32)

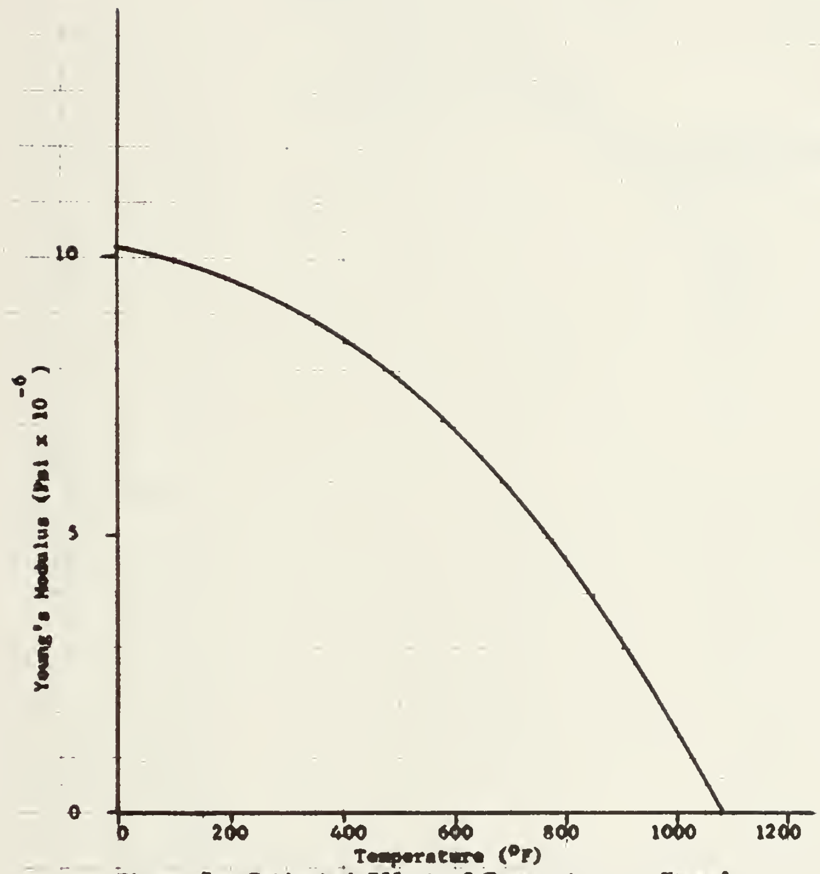


Figure 7: Estimated Effect of Temperature on Young's Modulus for 6061 in T6 Condition (31,32).

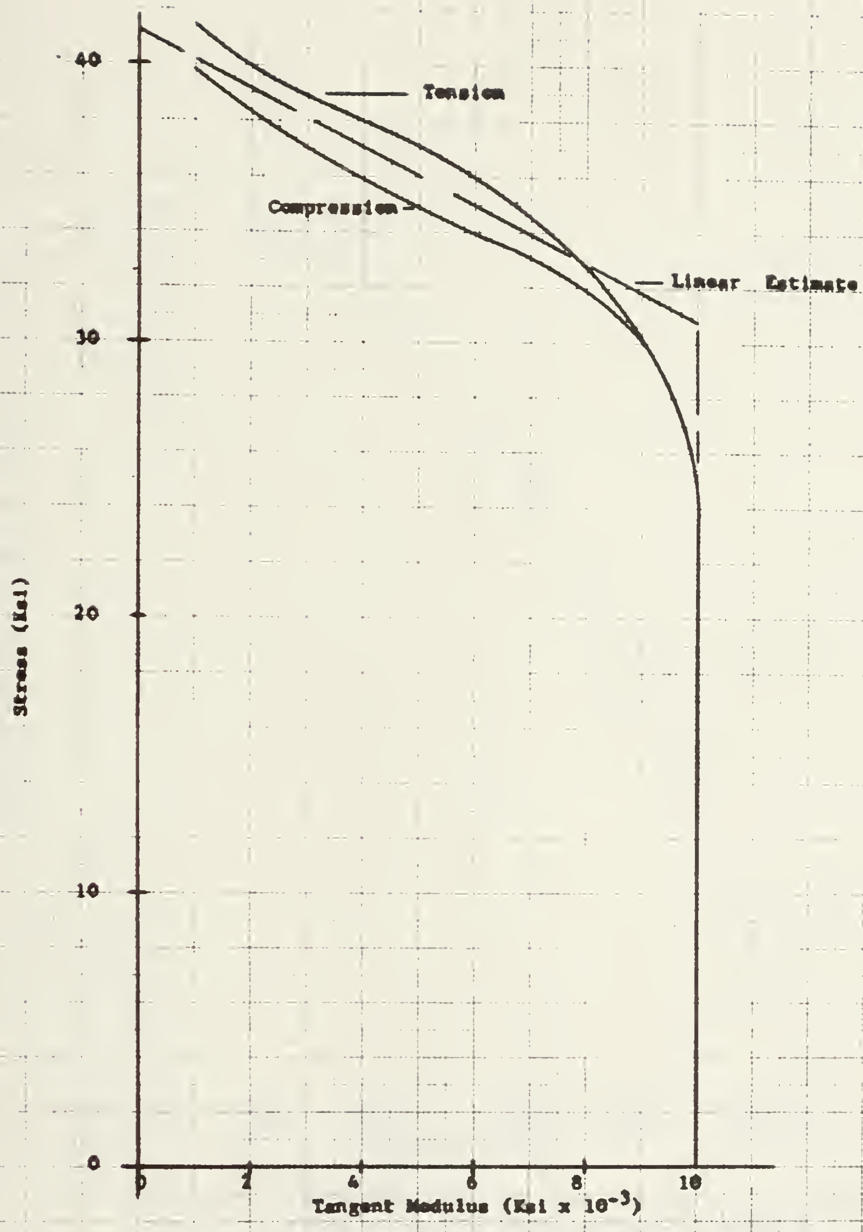


Figure 8: Tangent Modulus Curves for 6061 Sheet and Plate in T6 Condition. Thickness < 2 inches. (31)

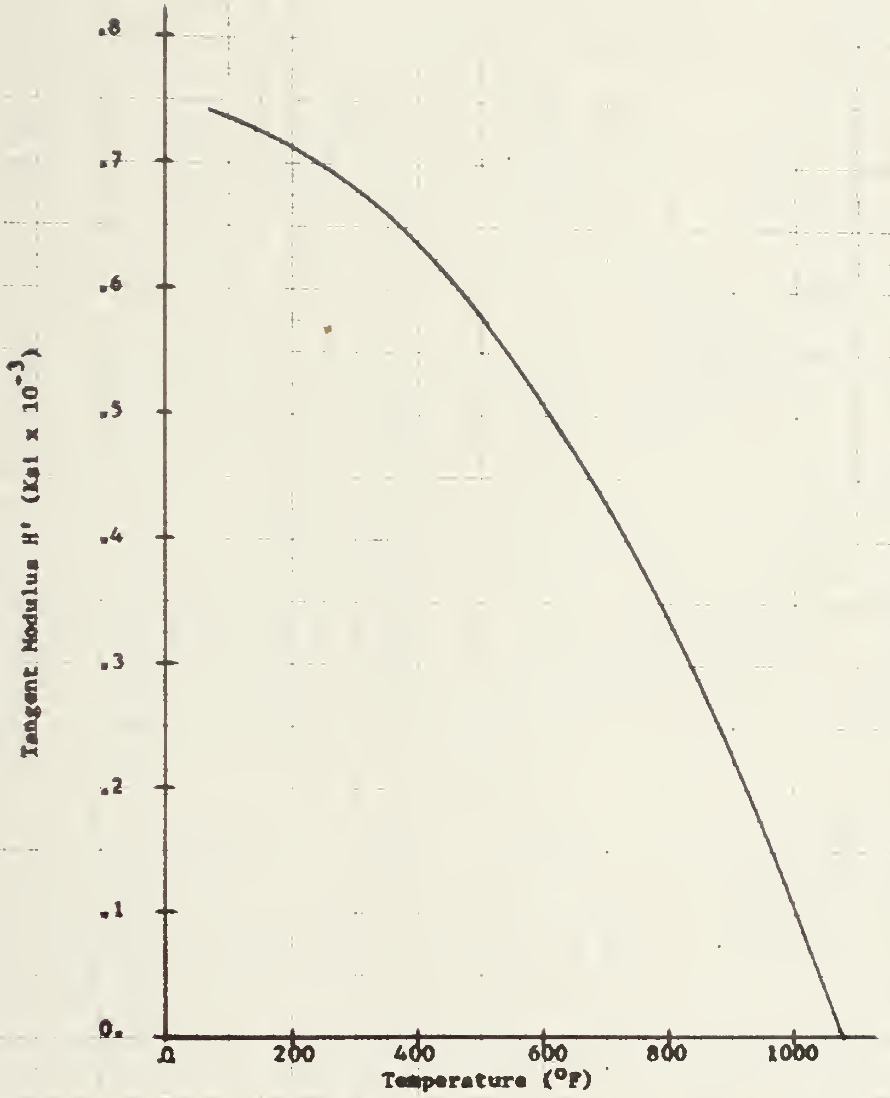


Figure 9: Tangent Modulus for 6061 in the T6 Condition Based on a Half Hour Exposure at Working Temperature (32).

FUNCTION:	RANGE	a	b	c	d
$\sigma_y(T)$Ksi	$0 < T^oF < 500$	0.4050000E 02	-0.7480200E-02	0.2589436E-04	-0.1698679E-06
$\sigma_y(T)$Ksi	$500 < T^oF < 1080$	0.1840897E 03	-0.5656120E 00	0.5837074E-03	-0.2016852E-06
$E(T)\times 10^{-6}$Psi	$0 < T^oF < 1080$	0.1020000E 02	-0.1817137E-02	-0.4810746E-05	-0.2084789E-08
$H'(T)\times 10^{-3}$Ksi	$0 \leq T^oF \leq 1080$	0.7520000E 00	-0.1240664E-03	-0.4036978E-06	-0.1168005E-09
$\alpha_T(T)$Microstrain/^oF	$0 < T^oF < 500$	0.1219000E 02	0.9464994E-02	-0.1169993E-04	0.1049988E-07
$\alpha_T(T)$Microstrain/^oF	$500 < T^oF < 1080$	0.1409189E 02	-0.6089211E-03	0.7212205E-05	-0.2243820E-08
$\bar{\alpha}_T(T)$Microstrain/^oF	$0 < T^oF < 600$	0.1241000E 02	0.4283324E-02	-0.2624947E-05	0.1041599E-08
$\bar{\alpha}_T(T)$Microstrain/^oF	$600 \leq T\ ^oF \leq 1080$	0.1332638E 02	0.1167117E-02	0.4798676E-06	0.2805547E-09
$\rho(T)$ Lb_m/in^3	$0 < T^oF \leq 300$	0.9800000E-01	-0.7683365E-05	0.1200050E-07	-0.1166804E-10
$\rho(T)$ Lb_m/in^3	$300 < T^oF < 1080$	0.9760000E-01	-0.3875000E-05		
$C(T)\times 10^{-2}$Btu/HrFt^oF	$0 \leq T^oF < 500$	0.2161000E 00	0.1197828E-03	-0.1859963E-06	0.1816616E-09
$C(T)\times 10^{-2}$Btu/HrFt^oF	$500 \leq T^oF < 1080$	0.2018934E 00	0.1561132E-03	-0.1503752E-06	0.7874967E-10
$H'(\sigma)\times 10^{-3}$Ksi	$30.8 < \sigma(Ksi) < 40.7$	0.3806400E 02	-0.9170000E 00		

Table 5: Summary of Mechanical and Physical Properties for Computer Simulation of 6061 T6 Aluminum Alloy in the Form $F(x) = a + bx + cx^2 + dx^3$. Use Caution in Reducing the Number of Significant Figures Given for the Coefficients at High Temperatures.

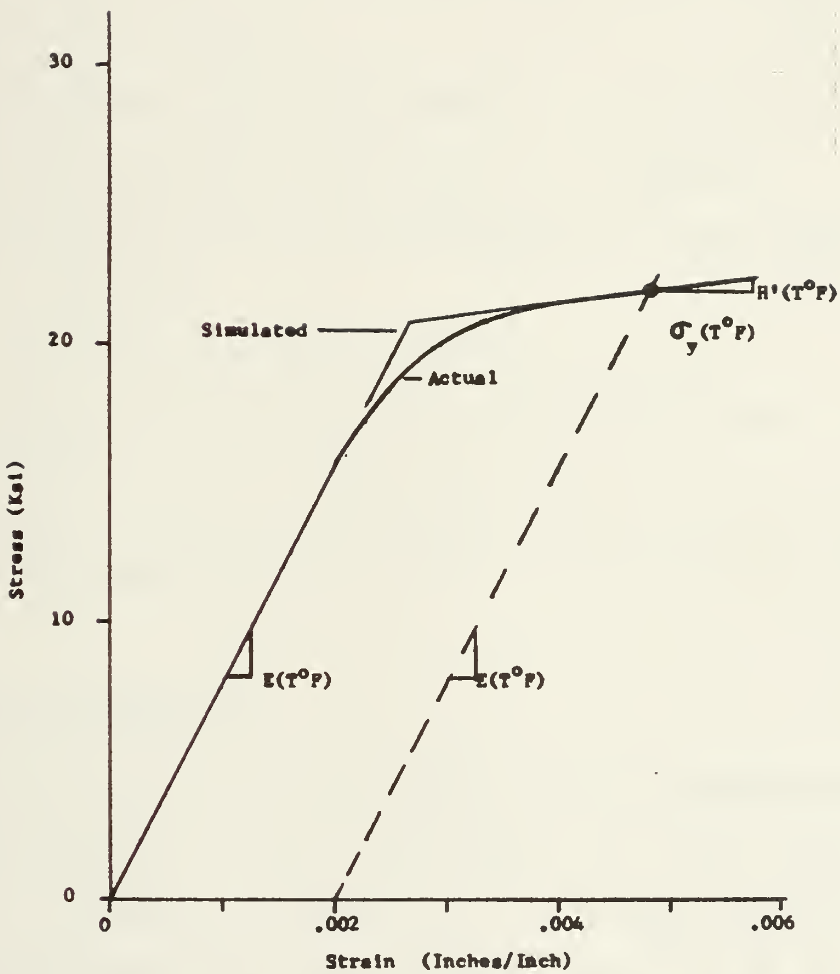


Figure 10: Simulation of Tensile Properties at Various Temperatures after 0.5 Hour at Temperature. In this example T°F is 300°F.

program.

Figure 10 also demonstrates a computer algorithm for the tensile properties at various temperatures based on the half hour soak. To determine this approximate value, proceed as follows:

a. Determine σ_y(T°F) from Table 5 or Figure 6.

b. Determine E(T°F) from Table 5 or Figure 7.

c. Determine H'(T°F) from equation (35) and Table 5 or Figure 9.

d. Plot σ_y(T°F) at 0.2% offset.

e. Draw line through point d above with slope H'(T°F).

f. Connect line in e above with line through origin with slope E(T°F).

5. Physical Properties

Figures 11 through 14 show the effect of temperature on the coefficient and mean coefficient of linear expansion α, density ρ, thermal conductivity κ, and specific heat C. The coefficient of linear expansion shown in Figure 11 is based on empirical equations for high purity aluminum and alloy constants provided by reference (35). The alloy constant for 6061 T0 is 0.990, i.e., 0.990 α (pure aluminum) = α (alloy). The value of this constant for heat treated tempers is approximately 0.015 greater. With these tempers, application is restricted to temper-

atures which do not appreciably exceed those used in the final aging treatments (320-350°F). The basic alloy constant is limited to temperatures below 600°F. Figure 11 is extrapolated past 600°F to the melting point. Figure 12 provides an estimate of density provided by reference (36) extrapolated to the melting point. Figure 13 provides an estimate of thermal conductivity. Reference (37, Volume II, Part 2, pp. 769) provides thermal conductivity information of 6000 series aluminum alloys from 300 to 650°K. A linear relationship was plotted parallel to this data passing through the one data point provided by reference (38). Reference (37) (Volume I, pp. 11) listed the specific heat-temperature relationship for pure aluminum. A parallel relationship (39, pp. 180) passing through the data point provided by reference (31, Code 3206, pp. 1) resulted in the estimated data shown in Figure 14.

These physical values may be approximated by the cubic polynomials given in Table 5 for computer simulation. Appendix A lists the computer program for determining the coefficients given in Table 5 and for testing these coefficients in 10°F increments.

Table 6 summarizes the physical and mechanical properties of 6061 T6 in the form utilized by Masubuchi and Andrews (11) in their one-dimensional program.

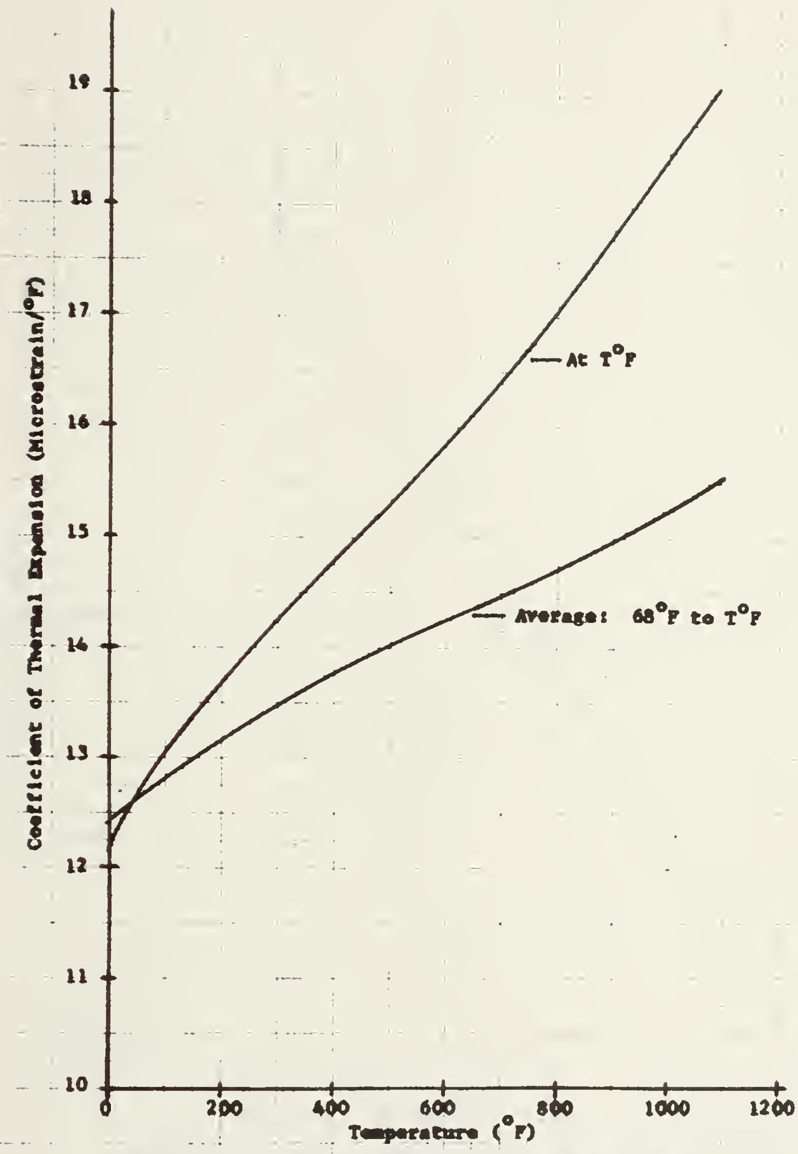


Figure 11: Coefficient of Thermal Expansion for 6061 (35).

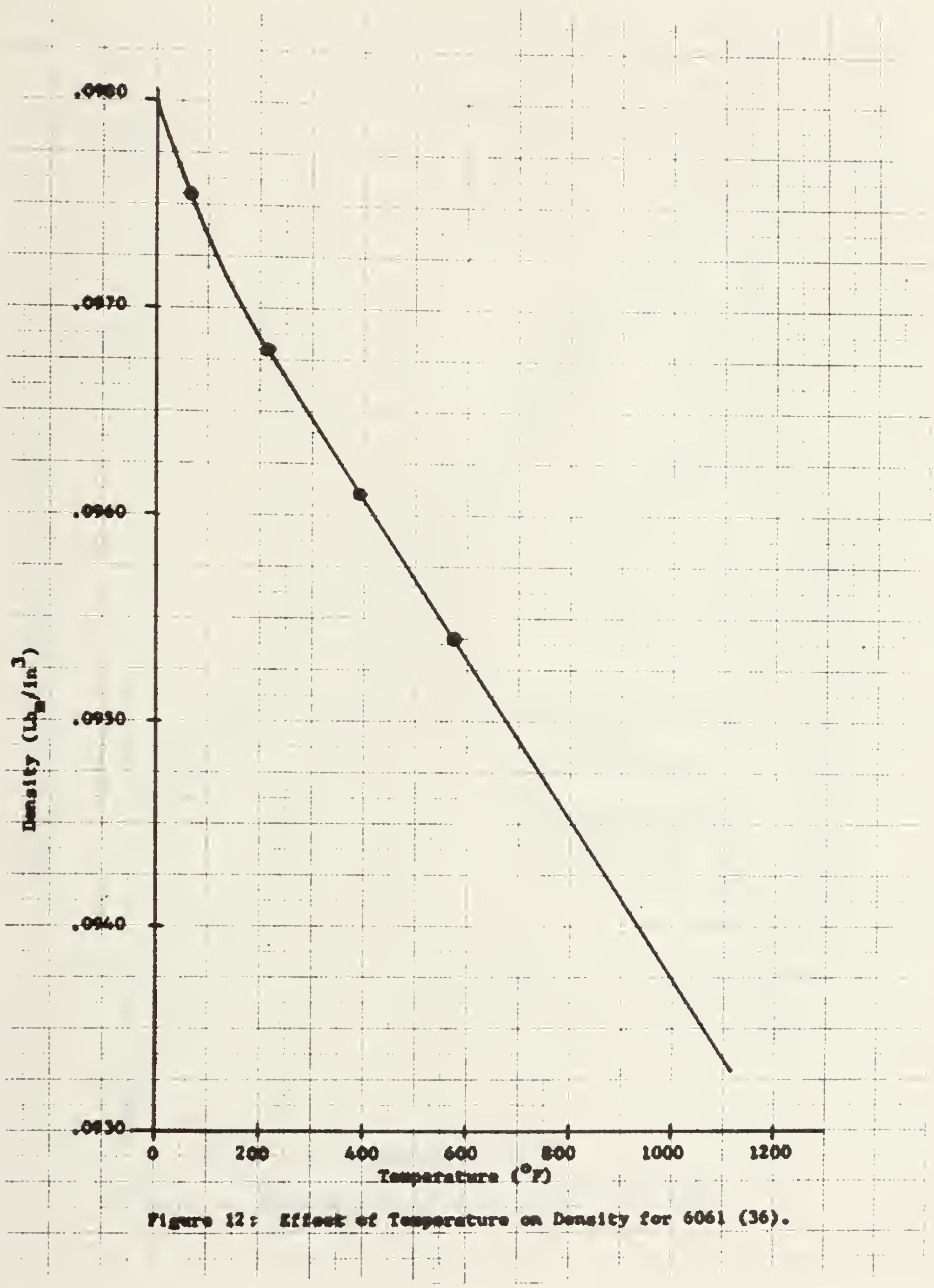


Figure 12: Effect of Temperature on Density for 6061 (36).

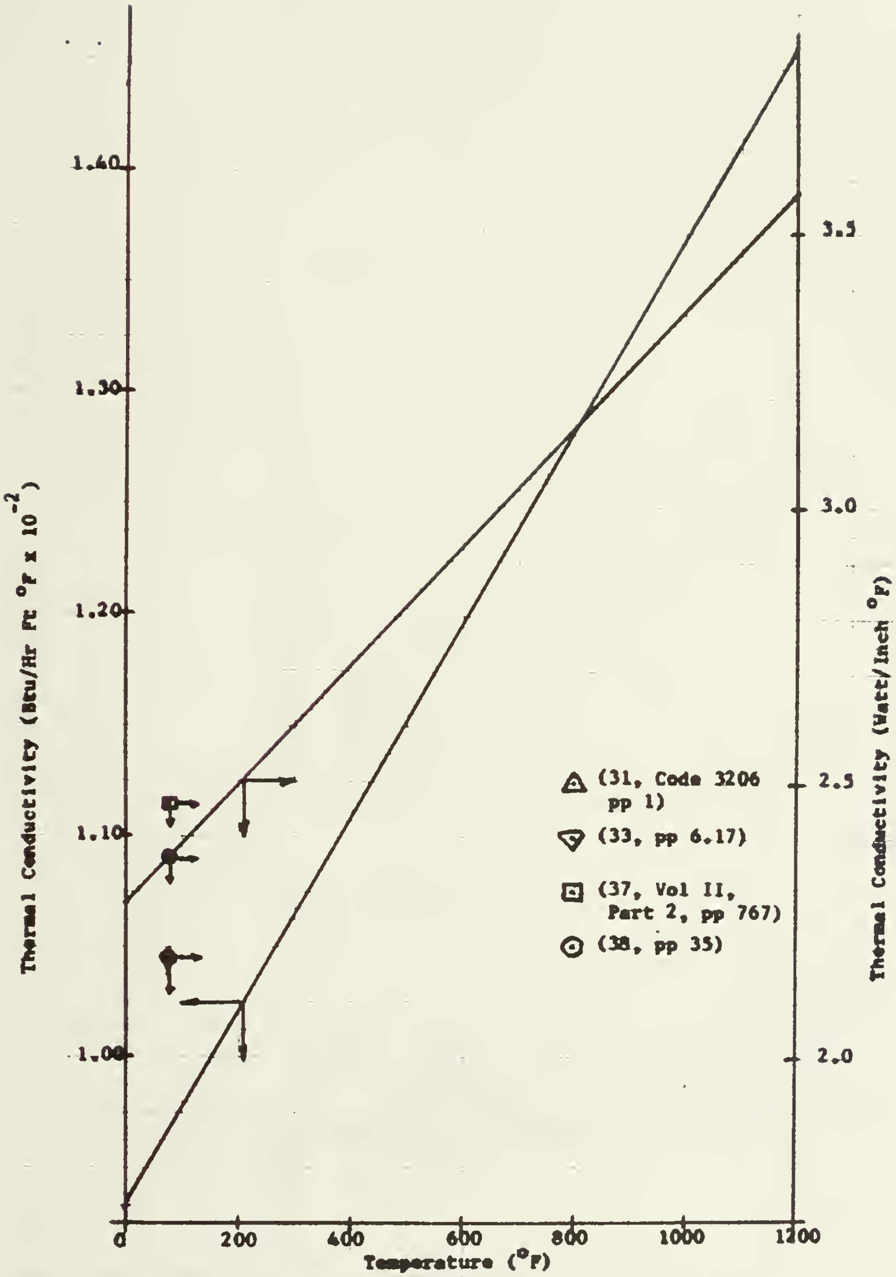


Figure 13: Estimated Effect of Temperature on Thermal Conductivity for 6061 in T6 Condition.

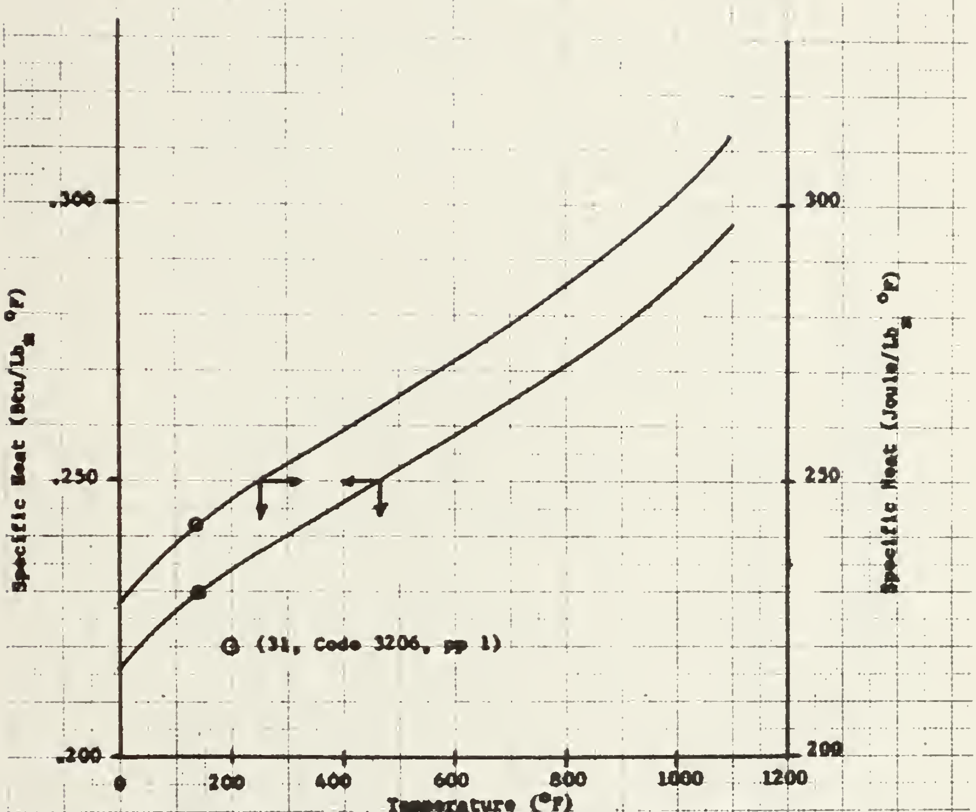


Figure 14: Estimated Effect of Temperature on Specific Heat for 6061 in T6 Condition.

T	^{o}F	0.0	100.0	200.0	300.0	400.0	500.0	600.0	700.0	800.0	1000.0
K	$Watt/In^{o}F$	2.280	2.389	2.497	2.603	2.712	2.838	2.925	3.062	3.142	3.572
C	$Joule/Lb_m{}^{o}F$	227.7	238.2	246.5	253.0	259.0	265.2	271.6	278.1	285.4	310.0
ρ	Lb_m/In^3	0.098	0.097	0.097	0.096	0.096	0.096	0.095	0.095	0.094	0.093
E	$x10^{-6}Psi$	10.18	9.94	9.60	9.15	8.58	7.83	6.93	5.85	4.60	0.00
σ_y	Ksi	40.50	39.80	38.38	36.00	31.70	22.00	9.60	5.00	2.60	0.00
α_T	$Microstrain/^{o}F$	12.19	13.03	13.67	14.26	14.78	15.31	15.85	16.43	17.06	19.02
m	-----	0.0742	0.0742	0.0742	0.0742	0.0742	0.0742	0.0742	0.0742	0.0742	0.0742

Table 6: Summary of Mechanical and Physical Properties for 6061 T6 Aluminum Alloy.

III: PROCEDURES

A. Scope of the Research:

A series of six experiments measuring temperature and strain changes during welding was performed. System models representing constrained bead-on-plate and butt joints were constructed from 6061 aluminum alloy in the T6 condition. Welding procedures were utilized which offered full penetration with minimum heat input. This allowed strain gage locations as close to the weld line as possible without exceeding the 400°F maximum allowable gage temperature limitation.

B. Selection of Parameters:

The aluminum selected for this investigation was picked because of its easy availability and wide use in the marine and aeronautical industries. It develops its strength from its heat treatment. The 0.250 inch plate thickness used in this study was determined by availability, past experimental work, ease of handling, and an interest in approaching a two-dimensional problem, yet minimizing the extent of bending and buckling. The joint design for the butt welds used in this experiment (straight) was selected for simplicity and ease of preparation. Steel backing plates were utilized below the weld and at

the clamped ends of the plates to provide support and distributed clamping and yet minimize heat conduction effects. Each specimen was clamped at its edges to a 0.500 inch mild steel bed plate which resisted deformation.

The size of the test plates was set at a nominal 18 by 30 inches to provide essentially steady state conditions at strain gage locations, and to approach the temperature distribution of an infinite plate.

The weld process used was semi-automatic Gas Metal-Arc (GMA or MIG). It allows control of weld variables, reduces operator error, and fosters repeatability. No preheating was necessary.

C. Strain Measurement by Electric Resistance Strain Gages:

The fundamental concept of strain gage operation is that certain conductors exhibit a change in electrical resistance with a change in strain. Gages designed according to this principle are attached to test materials whose strains are then monitored by measuring resistance variations across the gage. In the case of welding thermal strains, the observed resistance change, ΔR, is made up of:

$$\Delta R = \Delta R_1(\varepsilon_e) + \Delta R_2(\varepsilon_p) + \Delta R_3(\alpha T) + \Delta R_4(T)$$

where

$\Delta R_1(\varepsilon_e)$ = the resistance change corresponding to elastic mechanical strain, ε_e, from which stresses can be computed.

$\Delta R_2(\varepsilon_p)$ = the resistance change corresponding to plastic mechanical strain, ε_p, if it exists.

$\Delta R_3(\alpha T)$ = the resistance change corresponding to temperature induced thermal strain, αT.

$\Delta R_4(T)$ = the resistance change caused by thermo-electric effects in the gage itself.

While it is not presently possible to discriminate between the two mechanical strains, ε_e and ε_p, $\Delta R_3(\alpha T)$ and $\Delta R_4(T)$ can be separated out by physical temperature compensation of the strain gage material coupled with empirical calculation. For this investigation, α_T for the gage was approximately 13.0 microstrain/°F. The $\Delta R_4(T)$ and the difference between gage α_T and base plate α_T will then generate an error. To compute this error, a test gage of the type and lot used in the experiment is mounted on a small sample of 2024 aluminum alloy by the gage manufacturer. The sample is then heated at equilibrium until a curve of "apparent strain" vs. temperature is obtained to the operating temperature range. The gage readings recorded in the weld experiments can then be corrected by subtracting out the apparent strain

value corresponding to temperatures observed at the gage location. Figures 16 and 17 show this factory provided information for the individual gages and rosettes respectively. In each case, the curves have been reduced by the factory to fourth order polynomials yielding microstrain for ease in computer calculation.

Gage:

$$EAP = -69.36 + 2.07T - 2.02 \times 10^{-2}T^2 + 5.39 \times 10^{-5}T^3 - 3.27 \times 10^{-8}T^4 \qquad (38)$$

Rosettes:

$$EAP = -60.68 + 2.22T - 2.40 \times 10^{-2}T^2 + 7.05 \times 10^{-5}T^3 - 5.59 \times 10^{-8}T^4 \qquad (39)$$

Since 6061 T6 has a greater coefficient of thermal expansion than the 2024 T4 test plate, a correction to these polynomials has been made. This correction was calculated as follows:

In general,

$$\text{Thermal Strain} = \int_{T_1}^{T_2} \alpha(T)\, dT \qquad (40)$$

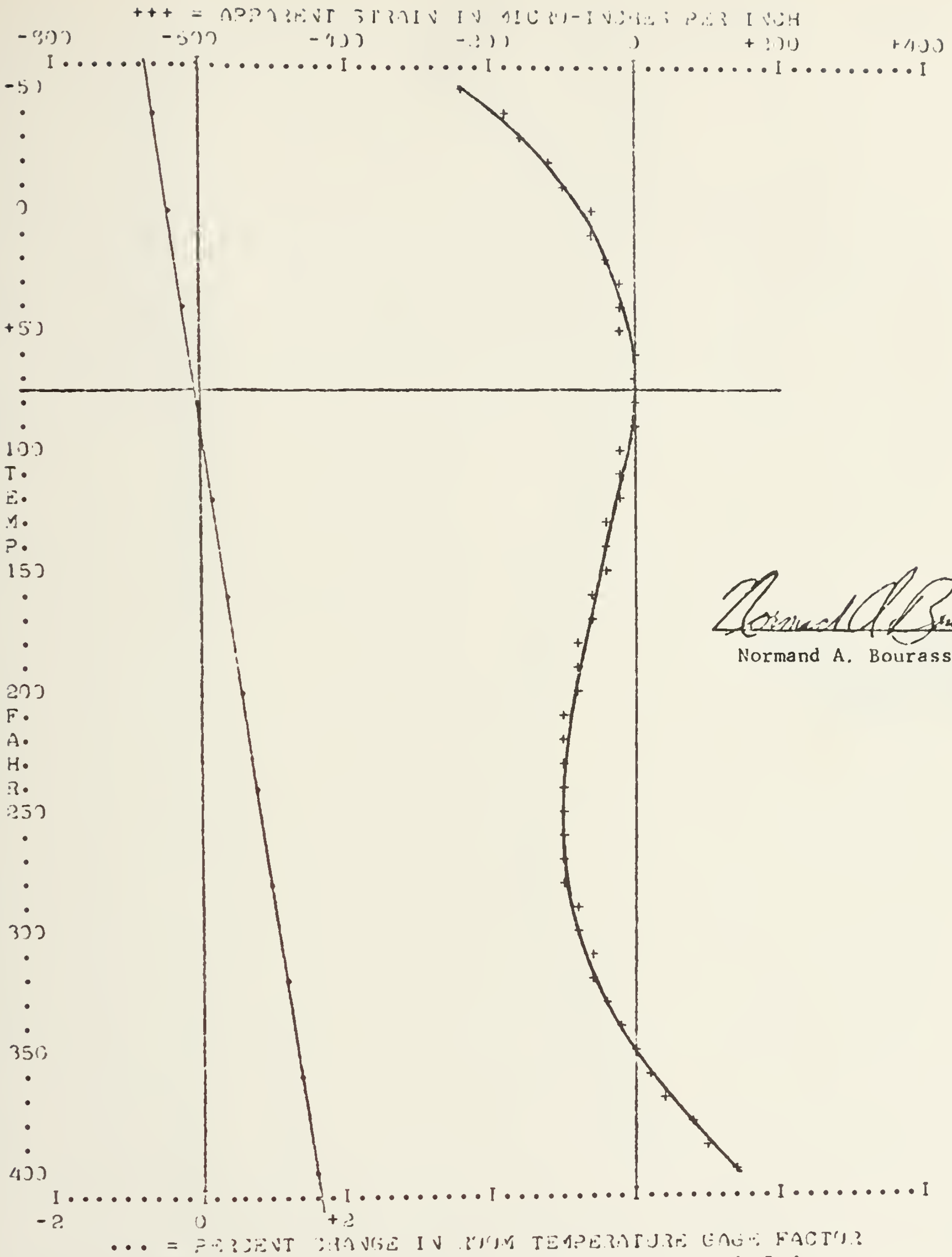
From reference (35),

$$\alpha_{6061} = C_{6061}\, \alpha \text{ pure Al.} = .99\, \alpha \text{ pure Al.} \qquad (41)$$

$$\alpha_{2024} = C_{2024}\, \alpha \text{ pure Al.} = .97\, \alpha \text{ pure Al.} \qquad (42)$$

$$\alpha \text{ pure Al.} = \frac{\alpha_{6061}}{.99} \qquad (43)$$

$$\Delta EAP = \int_{T_1}^{T_2} (C_{6061} - C_{2024})\, \alpha_{\text{pure Al.}}(T)\, dT \qquad (44)$$



Normand A. Bourassa

C O M P U T E R   P R O C E S S E D   D A T A

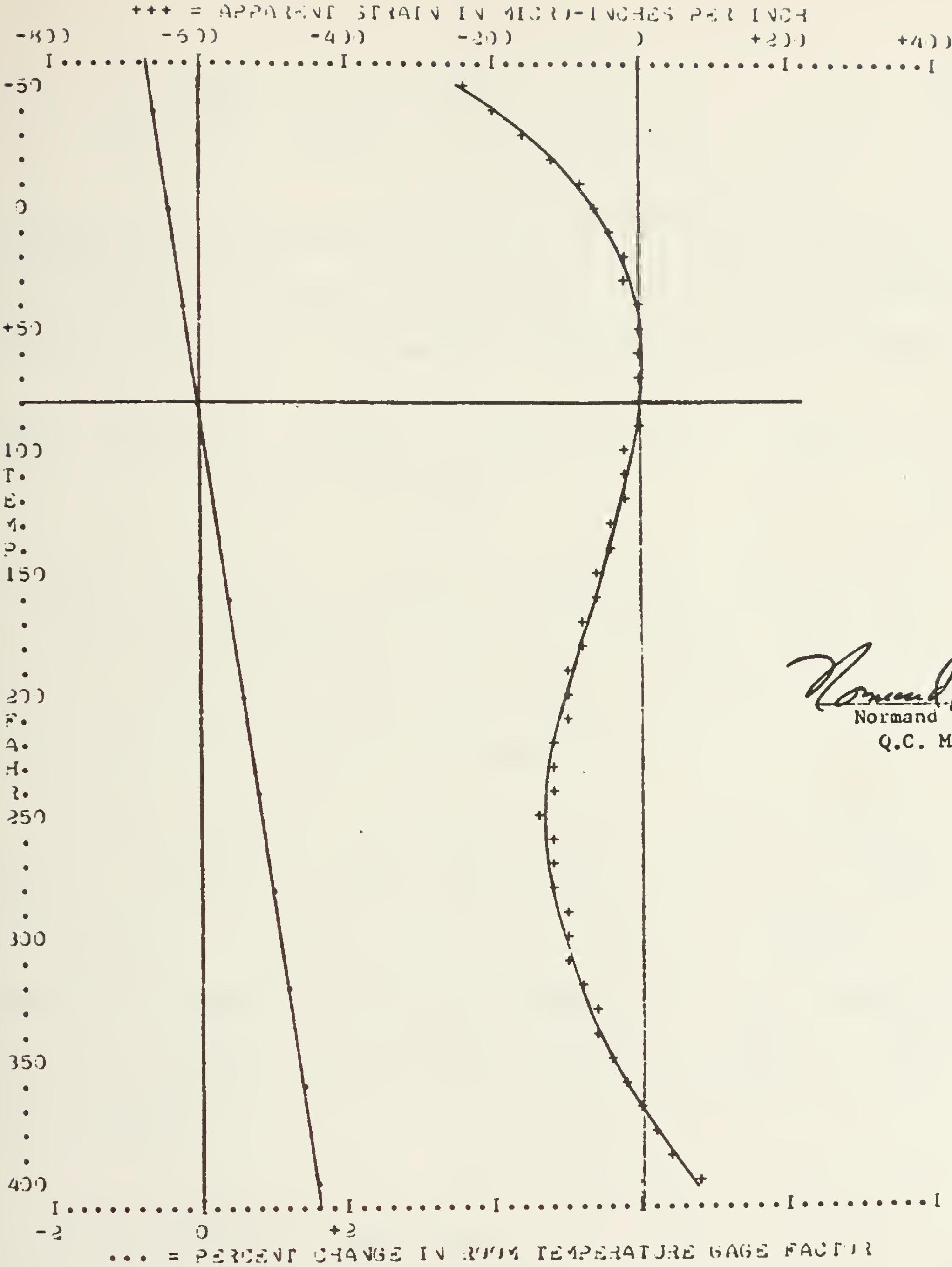
GAGE FAMILY FAB, FAE LOT NUMBER 284-1 SERIAL NUMBER ML

TEMPERATURE ERROR (APPARENT STRAIN) EQUATION

$$EAP = -69.36 + 2.07T - 2.02 \times 10^{-2}T^2 + 5.39 \times 10^{-5}T^3 - 3.27 \times 10^{-8}T^4$$

2024-T4 ALUMINUM TEST SPECIMEN 13.0PPM COEF. OF THER. EXP.

Figure 16: Apparent Strain Correction for FAE-25-12S13L Strain Gages Utilized in this Study.



C O M P U T E R P R O C E S S E D D A T A

GAGE FAMILY FAE, FAB LOT NUMBER 283-2 SERIAL NUMBER MI

TEMPERATURE ERROR (APPARENT STRAIN) EQUATION

$$E_{ap} = -60.68 + 2.22T - 2.40 \times 10^{-2}\,T^2 + 7.05 \times 10^{-5}\,T^3 - 5.59 \times 10^{-8}\,T^4$$

2024-T4 ALUMINUM TEST SPECIMEN 13.0PPM COEF. OF THER. EXP.

Normand Bourassa

Normand Bourassa
Q.C. Manager

Figure 17: Apparent Strain Correction for FAER-18RB-12S13-ET Strain Gage Rosettes Utilized in this Study.

$$\Delta EAP = \int_{T_1}^{T_2} \left(\frac{.20}{.99}\right) (\alpha_{6061}(T))\, dT \qquad (45)$$

Integrating the polynomial given in Table 5 for $\alpha_{6061}(T)$, $0 \leq T \leq 400°F$, between 77°F and T°F yields the following apparent strain correction for both gages and rosettes:

$$\Delta EAP = -19.4979 + .2463T + .9561 \times 10^{-4}T^2 - .7879 \times 10^{-7}T^3 + .5303 \times 10^{-10}T^4 \qquad (46)$$

Equation (46) must be added to equations (38) and (39) to obtain true apparent strain corrections. The true apparent strain is then subtracted from the actual strain to provide true mechanical strains.

Strain gages manufactured in the form of rosettes provide as many as three independent readings in three directions at a single location. This is enough to completely describe the two-dimensional strain state at that location (41, 42, 43) and is discussed in the next chapter.

D. Description of Apparatus:

1. Test Plates: A description of the test specimens is summarized in Figures 18 through 22 which provide dimensions and gage locations. Devices 1 through 12 were dynamically measured during welding. Gages 21 through 25 were statically measured before and after

o Thermocouple   Strain Gage   Strain Gage Rosette

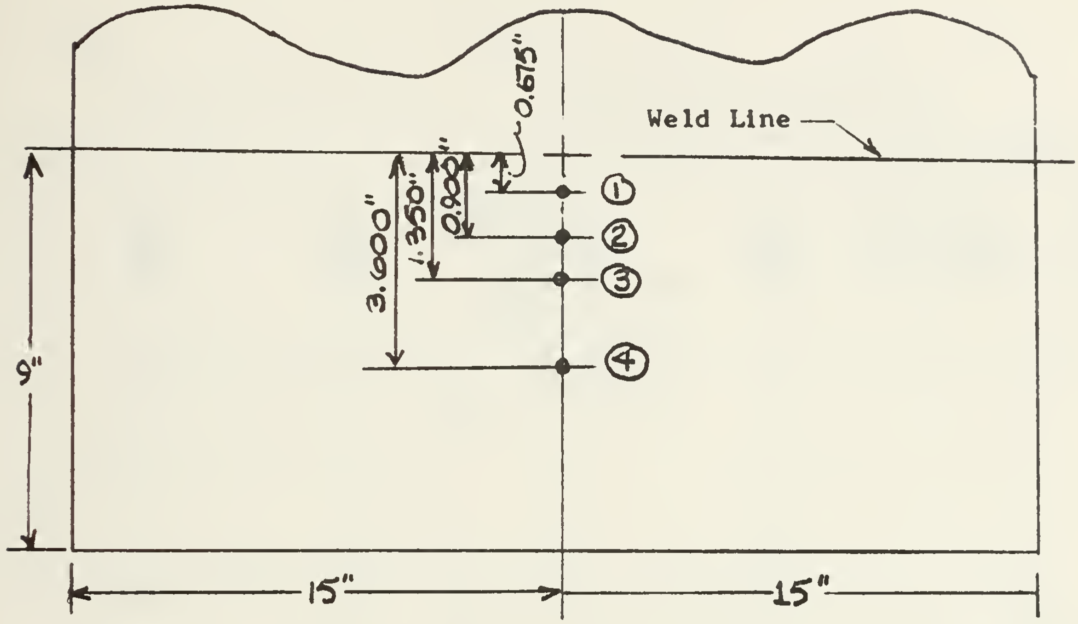


Figure 18: Test No. 1 and Test No. 2 (Butt and Bead-on-Plate Welds Respectively) Measuring Temperature Distribution.

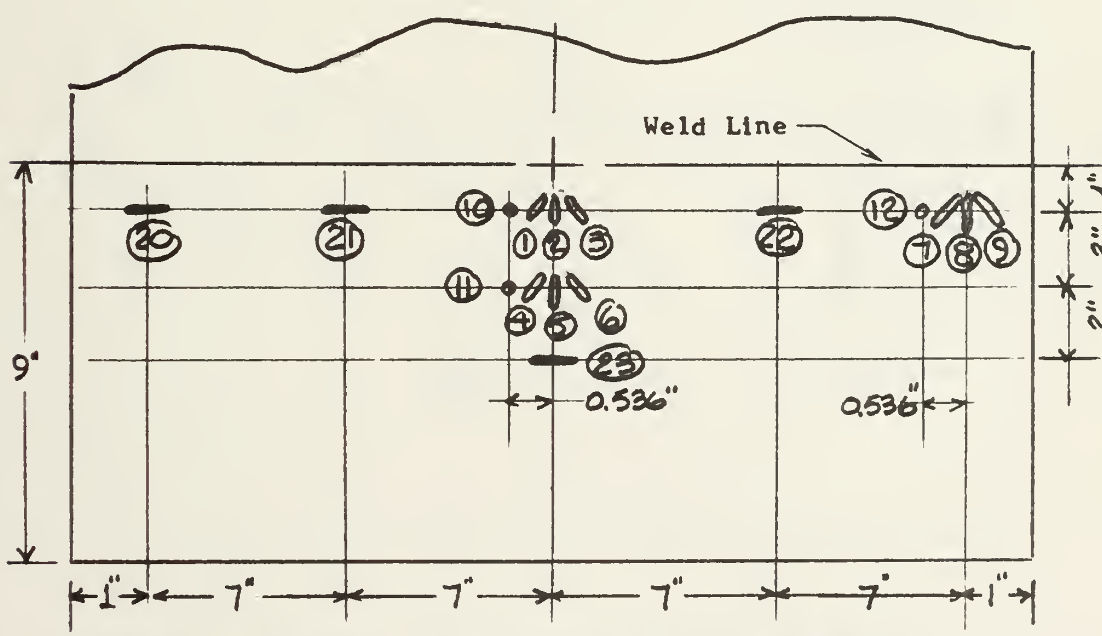


Figure 19: Test No. 3 (Bead-on-Plate Weld) Measuring Temperature Distribution and Strains.

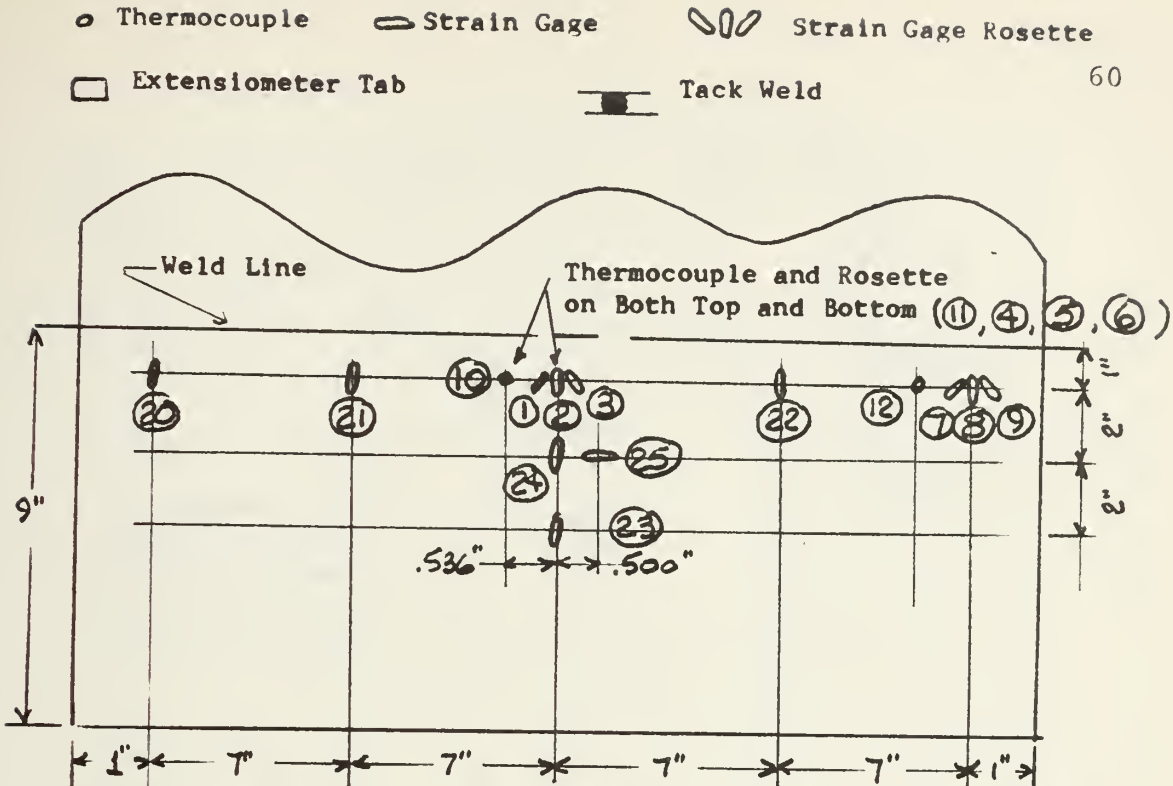


Figure 20: Test No. 4 (Bead-on-Plate Weld) Measuring Temperature Distribution and Strains.

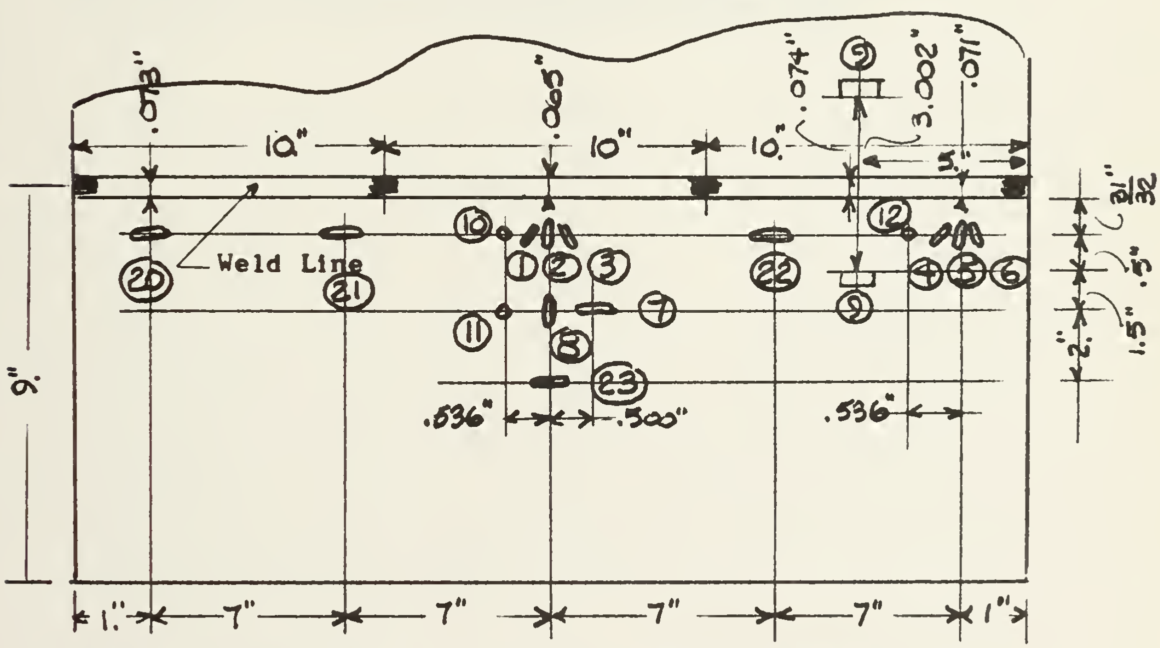


Figure 21: Test No. 5 (Butt Weld) Measuring Temperature Distribution, Strains, and Extension of Root Gap.

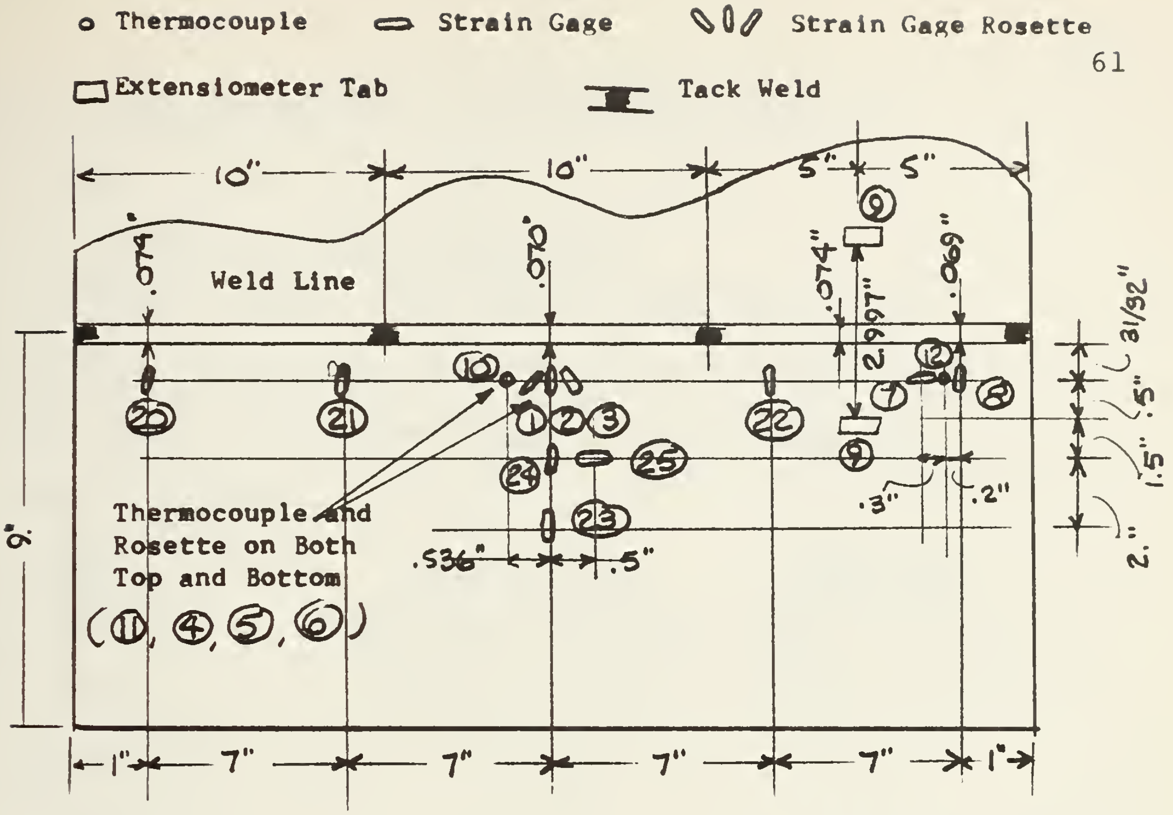


Figure 22: Test No. 6 (Butt Weld) Measuring Temperature Distribution, Strains, and Extension of Root Gap.

welding. The arrangement of constraining clamps is shown in Figure 23.

2. Sensors and Instrumentation:

a. Strain Gages. Two types of gages were used in this investigation: SR-4 foil 45° rosettes and SR-4 foil single element gages. Gage properties were as follows:

Gage	SR-4 Rosette	SR-4 Gage
Designation	FAER-18RB-12S13-ET	FAE-25-12S13L
Manufacturer	BLH Electronics	BLH Electronics
Grid Length (in.)	3/16	1/4
Grid Width (in.)	0.90	0.13
Overall Length (in.)	0.280	0.35
Overall Width (in.)	0.540	0.13
Temperature Range	-50 to +400°F	-50 to +400°F
Resistance	120.	120.
Gage Factor	2.03	2.07
Cement	EPY-600	EPY-600
Protective Covering	BLH Barrier-C	BLH Barrier-C

b. Temperature Sensors: All temperature sensors used were Chromel/Alumel thermocouples made from Leads and Northrup No. 28 wires. Each thermocouple was spot-welded onto the test specimen and protected by No. 33 Sauereisen Sealing Cement. Each was

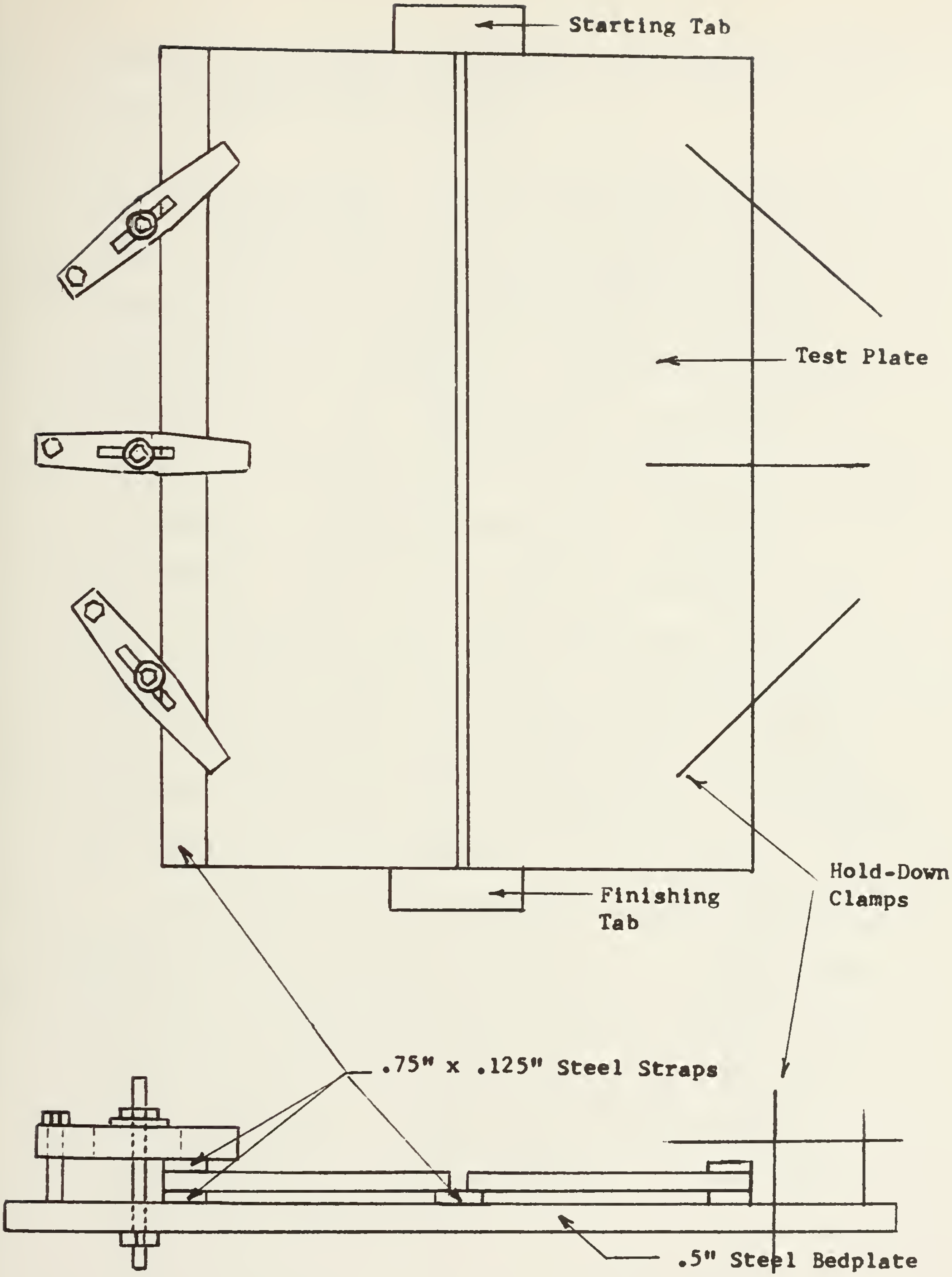


Figure 23: Constraining Equipment

located 0.536 inch (1 second of arc travel) ahead of the strain gage mid-axis.

c. Instrumentation. Strain gages were connected into a Potentiometric Circuit (Half-Wheatstone Bridge), balanced and calibrated as indicated schematically in Figure 24. Thermocouples were referenced to a 32°F ice-bath and calibrated as indicated in Figure 25. Both circuits were fed into a Honeywell continuous-recording, 12-channel Visicorder. When the raw data was actually read off the recorder tape, some traces were delayed or advanced with respect to others. This was done to correct for the finite difference in position along the weld line of the thermocouples (1 second) and strain rosette elements ($\pm$ 1/3 second).

This produces the effect of a simultaneous strain and temperature reading at the strain gage location. Timing was accomplished by means of an electric stop watch as well as a timer integral to the Visicorder. Static strain measurements were taken with a Budd Instrument Division Model P-350 strain indicator.

d. Extensiometer. Figure 26 shows a sketch of the extensiometer utilized in Tests 5 and 6. Strain

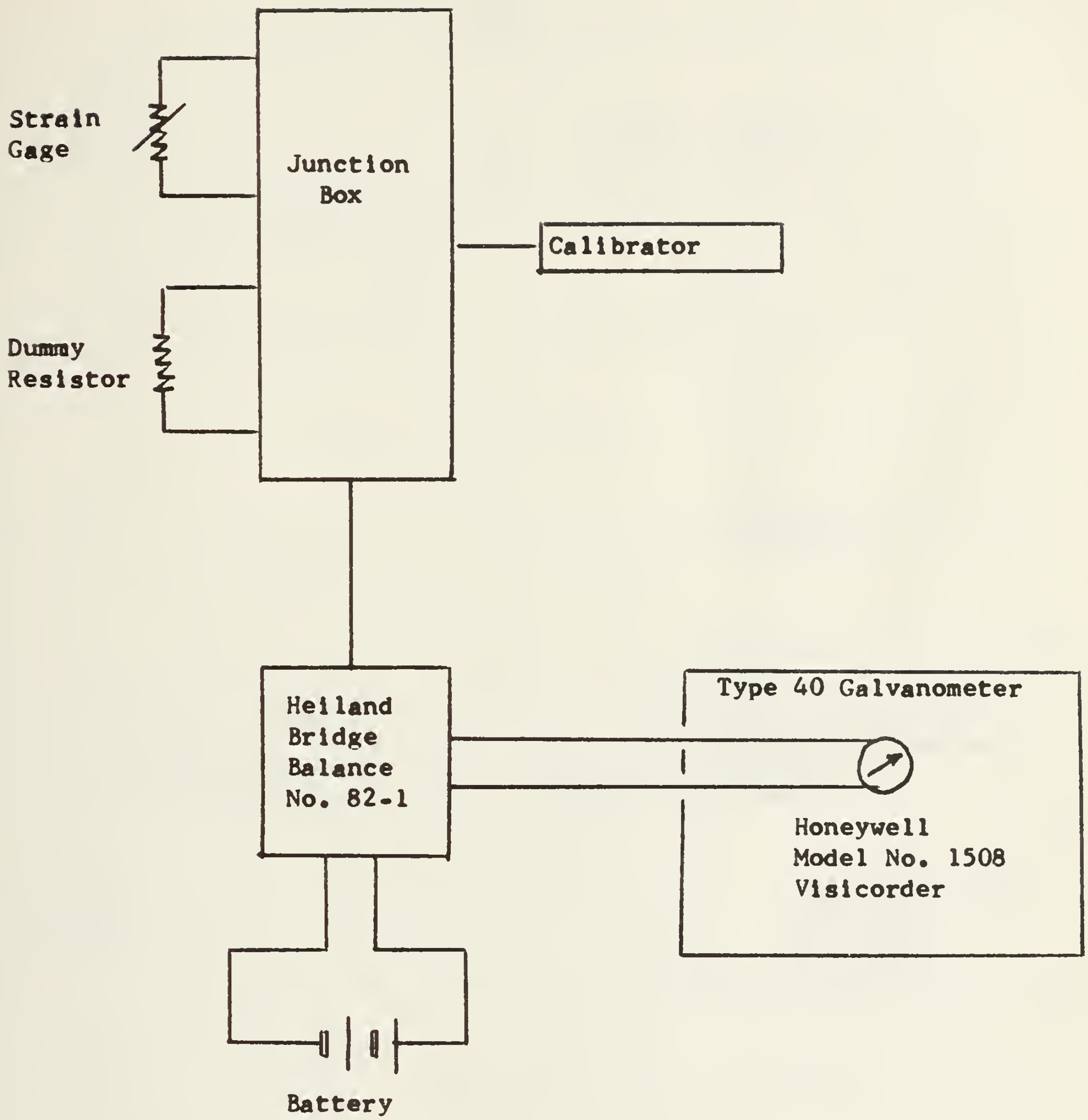


Figure 24: Strain Gage Instrumentation Circuit (7.)

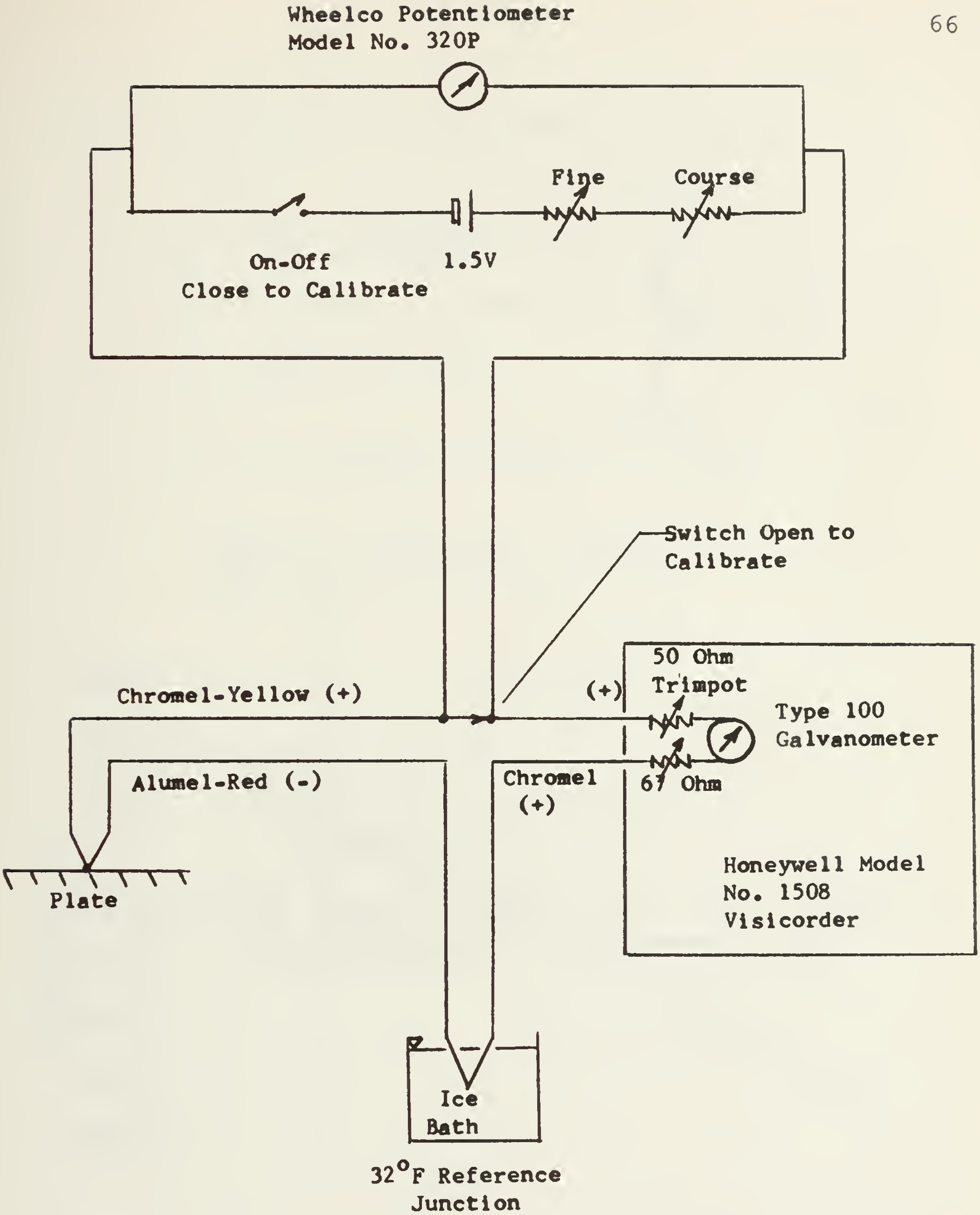


Figure 25: Thermocouple Instrumentation Circuit (7).

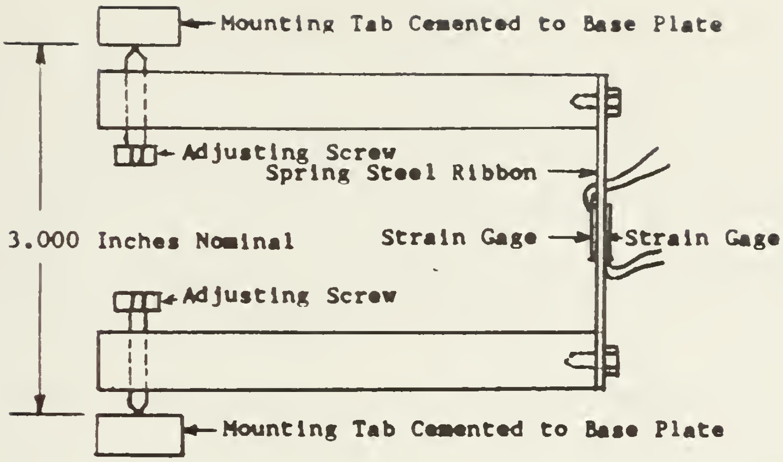


Figure 26: Extensiometer. The Adjusting Screws are Set So That the Spring Holds Extensiometer Firmly in Place.

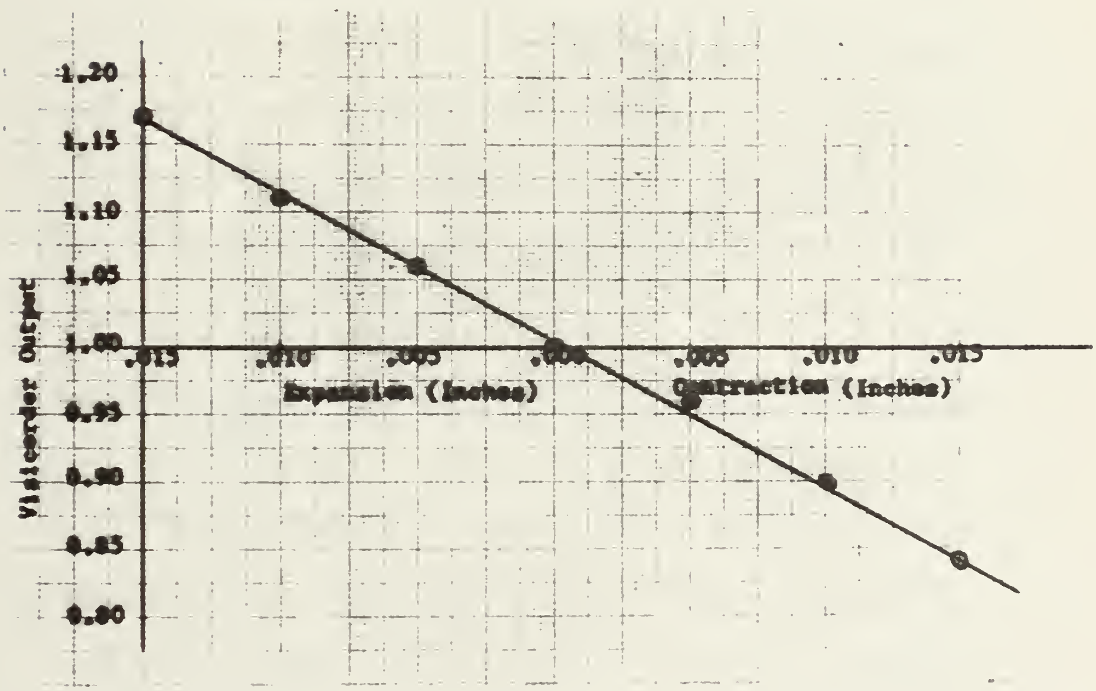


Figure 27: Extensiometer Calibration Curve. 0.000 Inches Represents an Extensiometer Gap of 3.00 Inches.

gages were located on both sides of a spring steel ribbon and connected into adjacent legs of the resistance network circuit described in paragraph c. above. The net effect of such a set-up is to double the bending sensitivity and null the stretching sensitivity. Figure 27 provides the calibration curve for the Visacorder referenced to actual dimensional changes in inches. The extensiometer and its mounting tabs may be seen in the photographs in Figures 28 through 31. It was pulled back away from the torch to prevent damage when the arc past the mounting tabs. Once the torch was safely clear, it was set back in place to observe weld shrinkage. It is noted that the mounting tabs were cemented in place with EPY 600 cement vice bolting or welding to minimize local straining of the base plate.

3. Welding Equipment and Conditions: Welding conditions are summarized in Tables 7 and 8. The welding machine utilized was manufactured by the Linde Division of Union Carbide Corporation and consisted of a type HW-16 GMA torch, a SVI-300 power supply, and associated governor, carriage and wire feed mechanisms. Travel speed, arc voltage, amperage and arc length were present to the same value for all experiments. Some fluctuations of amperage did exist when the geometry of the weld changed from

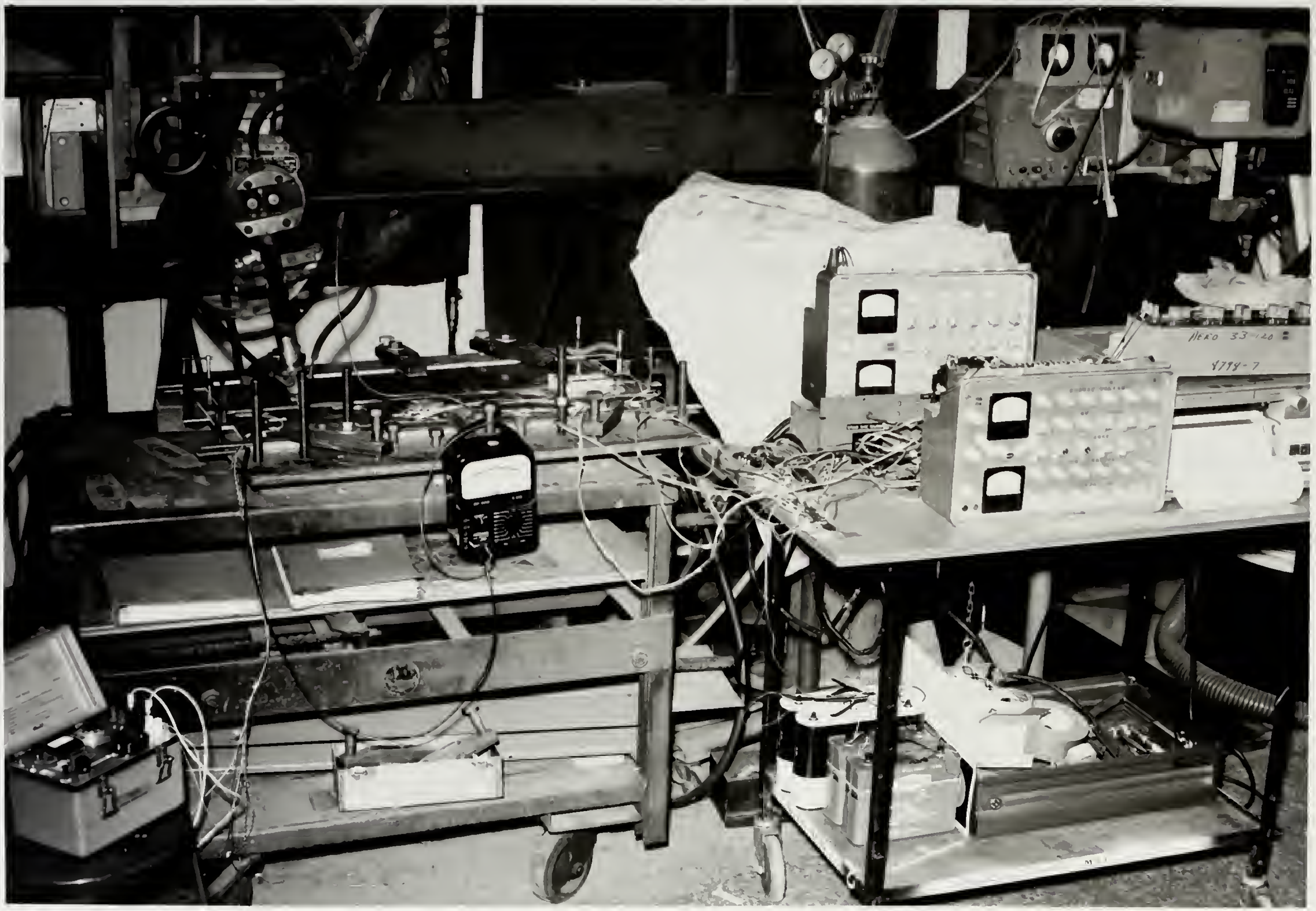


Figure 28: Overview of Experimental Equipment Showing Instrumentation and Recorder.

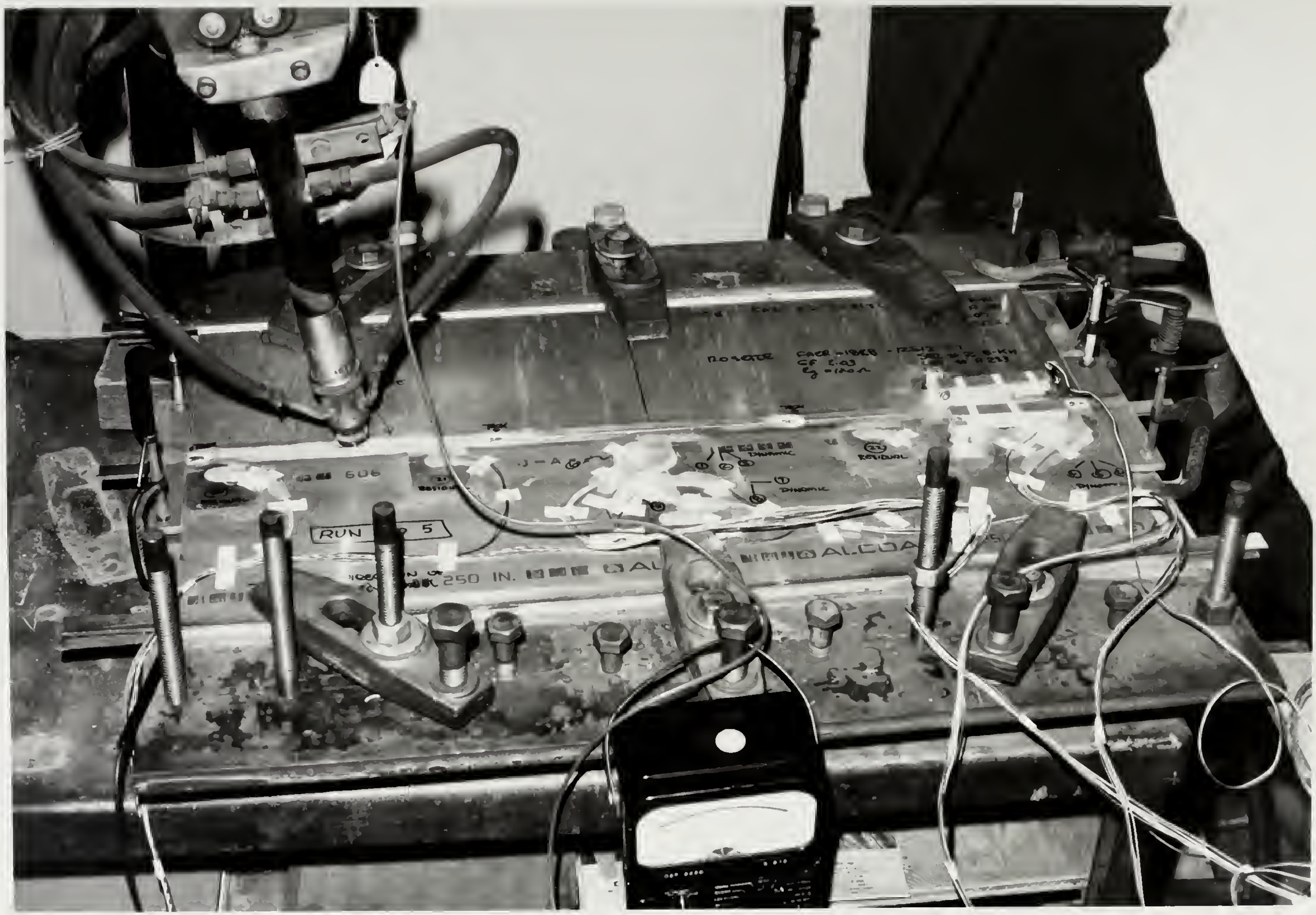


Figure 29: Plate Instrumented and Clamped Under Welding Torch.

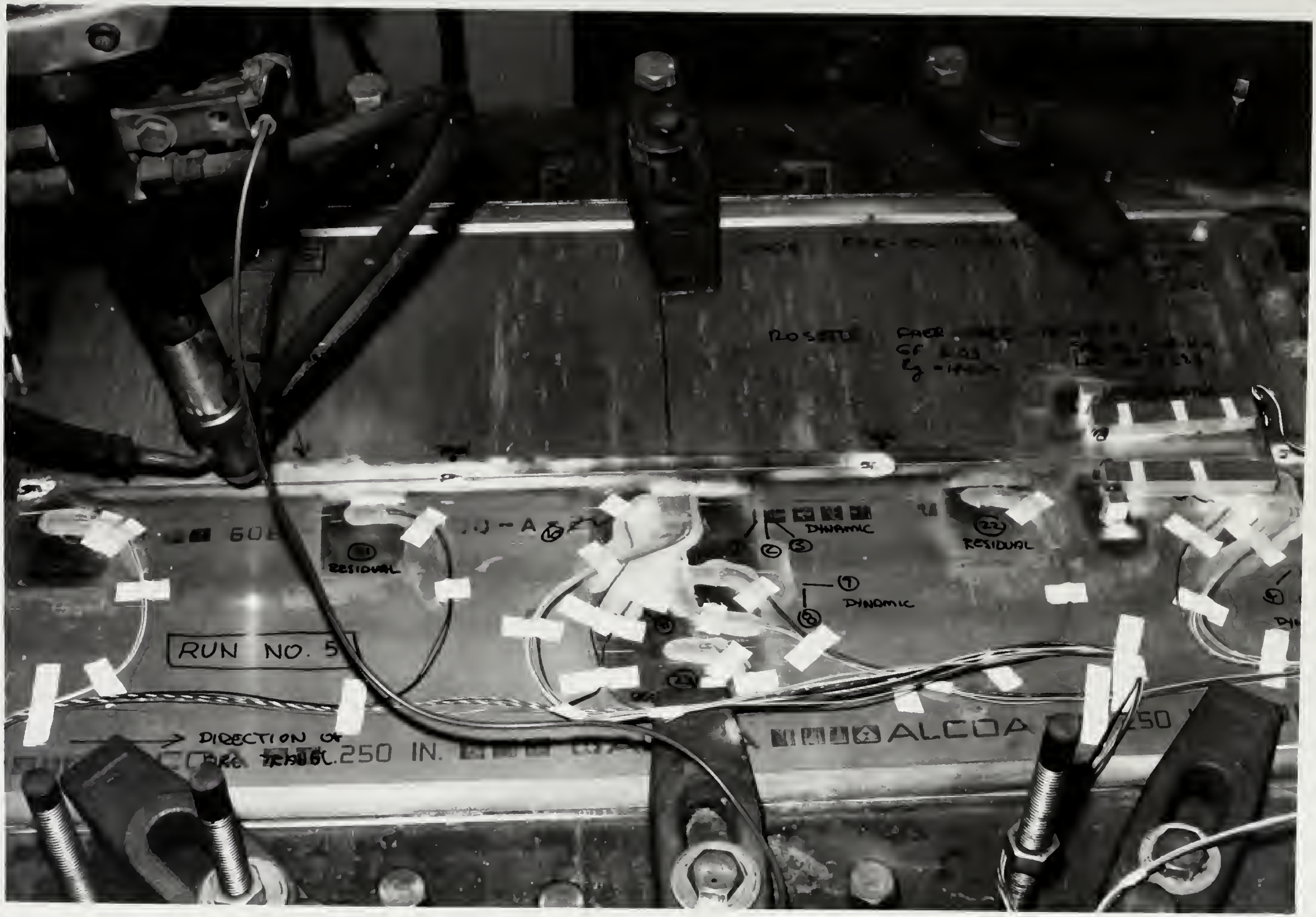


Figure 30: Plate Instrumented and Clamped Under Welding Torch.

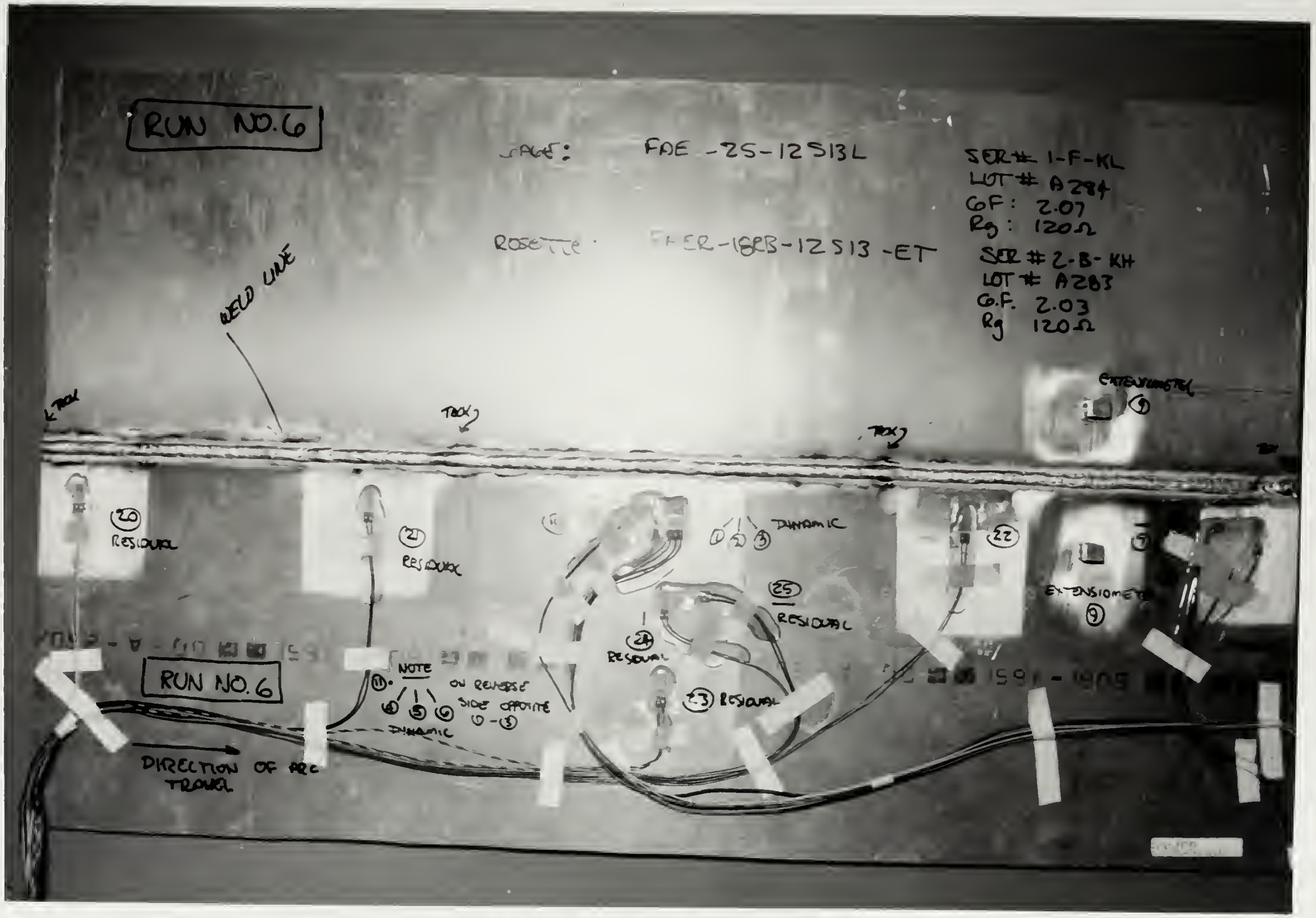


Figure 31: Sample Plated Instrumented and Welded.

bead-on-plate to butt. Wire feed is a functin of the other variables and was maintained by the machine automatically. Figures 29 through 31 are photographs of the actual equipment set-up.

E. Experimental Procedures:

The experimental operation is shown schematically in Figure 32. The test plate was instrumented and clamped into place. The welding machine was lined up with the joint and positioned over the run-off tab at the left end of the backing plate. Welding speed, arc voltage and amperage were pre-set. The visicorder was actuated and an arc was struck on the backing plate. As the welding torch crossed from starting tab to plate, the timer was started. The Visicorder output was marked when the arc passed the center strain gage location. When the welding bead reached the run-off tab at the right end of the plate, the arc was extinguished and the plate allowed to cool. Thr recorder continued to monitor the gages until the plate cooled to ambient temperature. After cooling, the plate was released from its clamp, and the new strains recorded either with the recorder or the Budd Instrument.

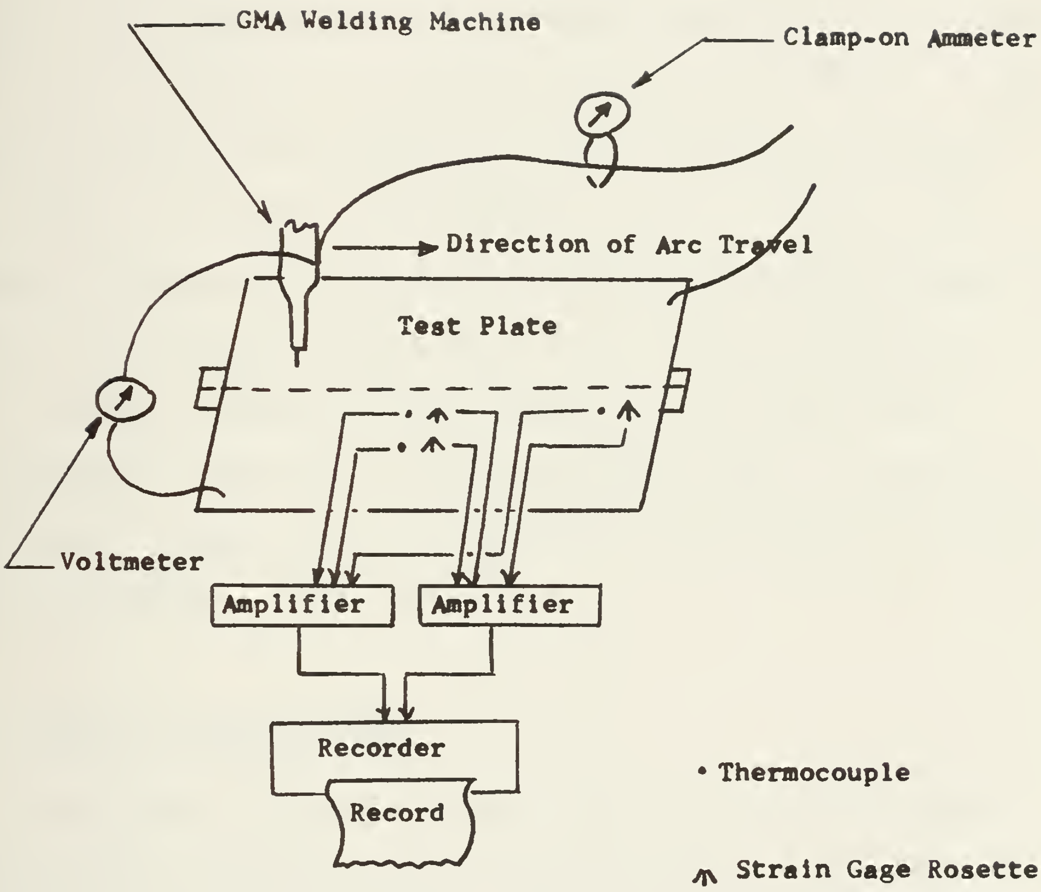


Figure 32: Schematic of Apparatus and Procedure. (7)

IV: DATA DEDUCTION

A. General:

At any point on a free (unloaded) surface of a solid, it is necessary to know three independent quantities in order to specify the state of stress completely. These quantities are the magnitudes of two principal stresses, σ_1, and σ_2, and their directions, ϕ or $(\phi + 90°)$, with respect to some reference. For isotropic elastic materials, these values can be calculated from strains measured on the surface at the point in question, and since three independent quantities are to be determined, it will be necessary to make three independent measurements of strain (42, pp. G2-03).

B. Strain Calculations:

Equation 47 describes the relationship for general strains for a three-element rosette shown in Figure 33.

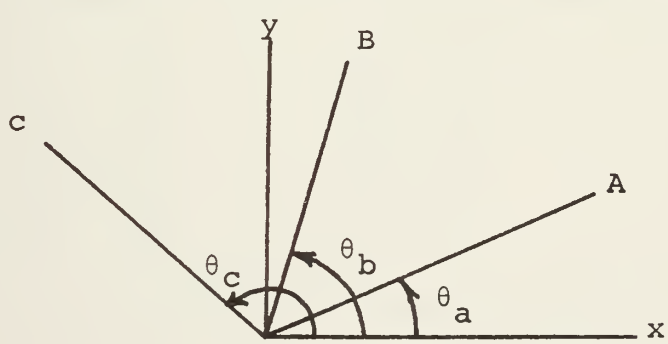


Figure 33

$$\begin{bmatrix} \varepsilon_a \\ \varepsilon_b \\ \varepsilon_c \end{bmatrix} = \begin{bmatrix} \cos^3\Theta_a & \sin^2\Theta_a & \sin\Theta_a\ \cos\Theta_a \\ \cos^2\Theta_b & \sin^2\Theta_b & \sin\Theta_b\ \cos\Theta_b \\ \cos^2\Theta_c & \sin^2\Theta_c & \sin\Theta_c\ \cos\Theta_c \end{bmatrix} \begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} \quad (47)$$

In the special case of a three-element 45° rectangular rosette shown in Figure 34,

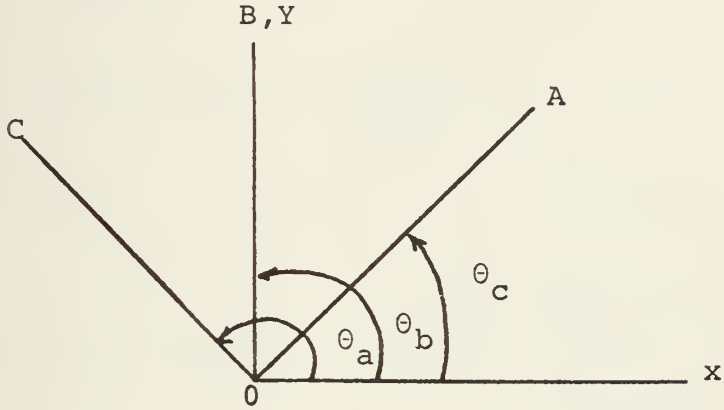


Figure 34

Equation (47) reduces to

$$\begin{bmatrix} \varepsilon_a \\ \varepsilon_b \\ \varepsilon_c \end{bmatrix} = \frac{1}{2} \begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 0 \\ 1 & 1 & -1 \end{bmatrix} \begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} \quad (48)$$

Solving Equation (48) for ε_x, ε_y, and γ_{xy},

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} 1 & -1 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} \varepsilon_a \\ \varepsilon_b \\ \varepsilon_c \end{bmatrix} \quad (49)$$

The Mohr's Circle for this special case is shown in Figure 35.

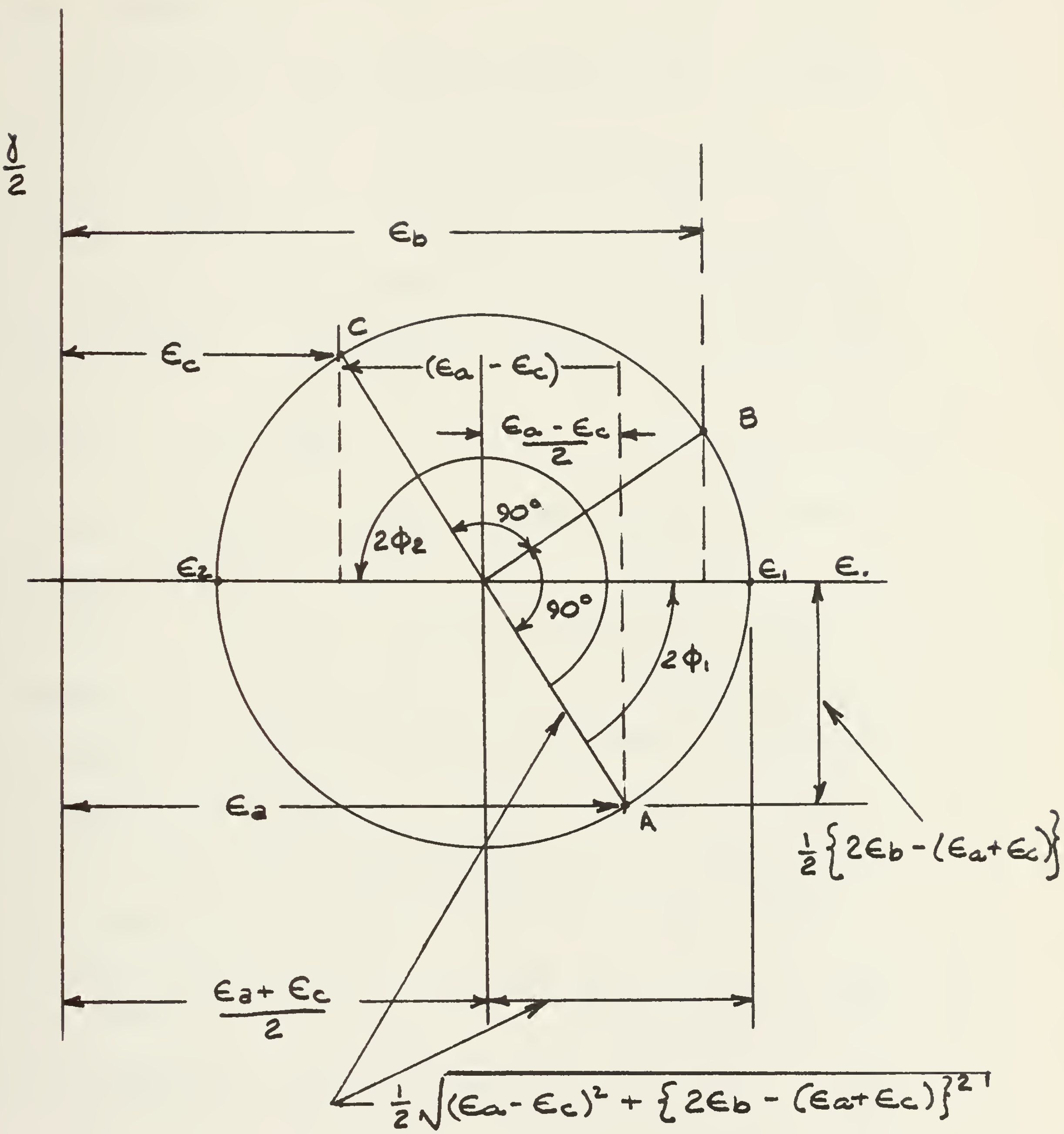


Figure 35: Mohr's Circle for the Rectangular Rosette With Three Observations of Strain (42, pp. G2-12).

Principal strains are

$$\varepsilon_1 = \left(\frac{\varepsilon_x + \varepsilon_y}{2}\right) + \frac{1}{2}\sqrt{(\varepsilon_x - \varepsilon_y)^2 + \gamma_{xy}^2} \qquad (50)$$

$$\varepsilon_2 = \left(\frac{\varepsilon_x + \varepsilon_y}{2}\right) - \frac{1}{2}\sqrt{(\varepsilon_x - \varepsilon_y)^2 + \gamma_{xy}^2} \qquad (51)$$

where ϕ is defined as the angle of one of the principal axes with respect to the axis of reference. Mathematically,

$$\text{Tan } 2\phi = \frac{\gamma_{xy}}{\varepsilon_x - \varepsilon_y} \qquad (52)$$

In the literature, there is considerable confusion concerning ϕ and which principal axis it defines. Murray (42, pp. G2-11, 15) offers a consistent method for dealing with this problem. If ϕ_1 is defined as the angle measured (positive in the anti-clockwise direction) from the positive OA axis of the strain rosette to the positive O1 axis which corresponds to the direction of ε_1, the algebraically largest principal strain, then:

Rule 1. When $\varepsilon_b > \dfrac{\varepsilon_a + \varepsilon_c}{2}$, then $0° < \phi_1 < 90°$ (53)

Rule 2. When $\varepsilon_b < \dfrac{\varepsilon_a + \varepsilon_c}{2}$, then $-90° < \phi < 0°$ (54)

Rule 3. When $\varepsilon_b = \dfrac{\varepsilon_a + \varepsilon_c}{2}$ (55)

and (a) $\varepsilon_a > \varepsilon_c$, then $\varepsilon_a = \varepsilon_1$ and $\phi_1 = 0°$ (55a)

or (b) $\varepsilon_a < \varepsilon_c$, then $\varepsilon_a = \varepsilon_2$ and $\phi_1 = \pm 90°$ (55b)

Rules 1 through 3 are defined with axis OA as the reference. To convert to the situation consistent with this investigation, axis OA is +45° (anti-clockwise) from the x-axis.

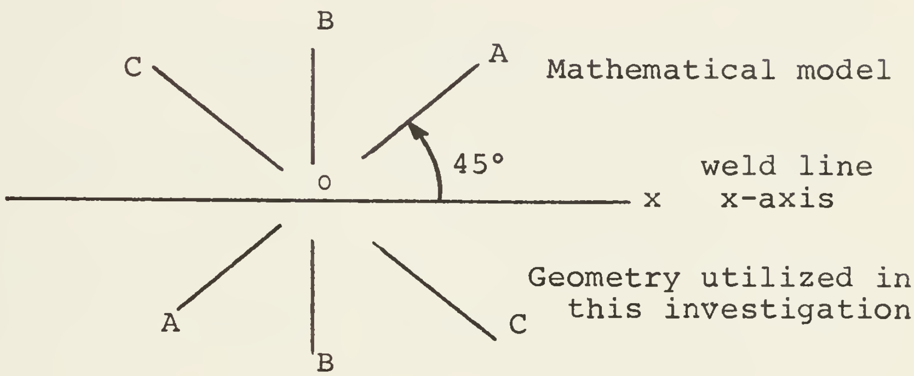


Figure 36

$$\phi_x = \phi_1 + 45° \qquad (56)$$

The geometry utilized in this investigation reduces to that of the mathematical model if the axes are kept consistent with Figure 36.

C. Stress Calculations:

This investigation yields mechanical strains. The automatic temperature compensating feature of the strain gage coupled with the apparent strain correction removes the thermal strain effect. Stresses must be determined by total strain.

$$\varepsilon_{mech} + \varepsilon_{thermal} = \varepsilon_{total} \qquad (57)$$

where

$$\varepsilon_{thermal} = \int_{T_1}^{T_2} \alpha(T)\, dT \tag{40}$$

For general two-dimensional stress calculations,

$$\sigma_x = \frac{E}{1 - \nu^2} (\varepsilon_{x_{total}} + \nu\varepsilon_{y_{total}}) \tag{58}$$

$$\sigma_y = \frac{E}{1 - \nu^2} (\varepsilon_{y_{total}} + \nu\varepsilon_{x_{total}}) \tag{59}$$

$$\sigma_1 = \frac{E}{1 - \nu^2} (\varepsilon_{1_{total}} + \nu\varepsilon_{2_{total}}) \tag{60}$$

$$\sigma_2 = \frac{E}{1 - \nu^2} (\varepsilon_{2_{total}} + \nu\varepsilon_{1_{total}}) \tag{61}$$

For this particular configuration,

$$\gamma_{xy_{mech}} = \varepsilon_a - \varepsilon_c = \gamma_{xy_{total}} \tag{62}$$

$$\tau_{xy} = G\gamma_{xy} = \frac{E}{2(1 + \nu)} \gamma_{xy} \tag{63}$$

ν is Poisson's ratio. Nominally, $\nu = .333$ for aluminum. ν will probably change with temperature, but should not exceed a maximum value of .500 in the weld puddle because of volume consideration when melted (at .500, there will be no volume change).

Stress calculations are dependent upon E(T) and α(T) assuming ν is relatively independent of temperature. These

values may be determined from Table 5 in Chapter II. The values of E(T) given assumes that the value from a half-hour soak approximates that from welding.

D. Determination of Plastic Conditions:

Masubuchi (43) theorizes that the region in the vicinity of the weld has undergone plastic deformation when the invarient I is larger than the value of yield stress, where,

$$I = (\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau_{xy}^2)^{1/2} \qquad (64)$$

This value was derived from the second stress deviator tensor invariant J_2 (44, pp. 41) which for a two-dimensional situation is reduced to

$$J_2 = \frac{1}{3}(\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau_{xy}^2) = \frac{1}{3}I^2 \qquad (65)$$

The Distortion Energy Theory (Von Mises' Yield Criterion) at the yield point in simple tension (44, pp. 75) predicts that

$$J_2 = \frac{1}{3}\bar{\sigma}^2 \qquad (66)$$

Equating Equations (65) and (66)

$$J_2 = \frac{1}{3}I^2 = \frac{1}{3}\bar{\sigma}^2 \qquad (67)$$

or

$$I = \bar{\sigma} = \sqrt{3J_2} \qquad (68)$$

Therefore, a check to see if plastic conditions exist would occur is that

$$\frac{I\ (T)}{\bar{\sigma}\ (T)} \geq 1.0 \tag{69}$$

It is important to note that any single component of the stress field in Equation (65) may be greater than the yield stress in simple tension without having yield occur.

Again, the yield stress is determined from Table 5 in Chapter II.

E. Data Reduction Program:

Appendix B lists the basic program utilized for rosettes in this investigation. It is modified slightly to suit other geometries (rosettes in different locations) or slightly different welding conditions. Input cards are listed as comment cards in the main program and samples are shown in the appendix. In the case where all strains are zero or equal, the program defaults to $\phi_x = 90°$. For example, if at time = 0.0 the strains are initialized to zero, the resulting ϕ_x at time = 0.0 is meaningless. In the case where initial strains at time = 0.0 are not zero, the program will reference all succeeding strains to their initial value. Single element strain gage data may be processed by this same program to provide temperature compensation.

V RESULTS:

A. General Trends:

Figures 37 through 59 graphically present part of the experimental data tabulated in Appendix C. Table 7 discusses the particular problems and parameters associated with each test. Several effects are discussed below:

1. Arc Efficiency. Figures 37 through 40 show the temperature distributions for Test No. 1 and 2, and also the one dimensional computer analysis results for $\eta = 0.70$ and 0.75. The $\eta = 0.75$ curve seems to fit the data best. This efficiency factor includes all heat loss effects associated with the heat generation and cooling. The tail of the experimental temperature distribution is higher than the computer analysis because, geometrically, the experimental plates are not infinite and cool slower than the computer model.

2. Placement of Strain Gages. Figure 41 shows the transverse temperature distribution based on Figures 37 through 40. In general, the peak temperature predicted at transverse locations are supported by the testing shown in Figures 42 through 44. Figure 41 provides an effective technique for positioning strain gages to prevent damage or exceeding their temperature compensation limits.

Test Number	I Amperes	V Volts	v Inch/Sec.	Heat Input Joules/Inch	Comment
1.	230	20	0.536	8582	Butt weld to measure temperature distribution only. Immediately opposite thermocouple line arc burned a deep crater in the weld. Temperature distribution at 0.675 inch reflects problem. During last quarter of run, arc cut more plate than it welded. More tacks are required, i.e., shift from 2 to 4.
2.	220	20	0.536	8209	Bead-on-plate to measure temperature distribution only
3.	240	19	0.536	8507	Bead-on-plate to measure temperature distribution and strains. Sensitivity of Visicorder set low.
4.	240	19	0.536	8507	Bead-on-plate to measure temperature distribution and strains. Strain readings in the vicinity of the arc on all rosettes appeared erratic. Strains were much higher than expected.
5.	250	19	0.536	8862	Butt weld to measure temperature distribution and strains.
6.	250	19	0.536	8862	Butt weld to measure temperature distribution and strains. Gages 4 and 5 failed after arc passed by in vicinity of highest strains at 30+ seconds. At 42 seconds, Visicorder paper ran out and all remaining data was lost.

Table 7: Summary of Welding Conditions for Each Test

Test Number	I: Amperes	V: Volts	v: in./min	t: inches	EI/vt: Watt-min/in^2	b_h inches
1.	230	20	32.16	.250	572.14	0.488
2.	220	20	32.16	.250	547.26	0.473
3.	240	19	32.16	.250	567.16	0.485
4.	240	19	32.16	.250	567.16	0.485
5.	250	19	32.16	.250	590.80	0.499
6.	250	19	32.16	.250	590.80	0.499

TABLE 8: Summary of Extent of HAZ (b_h)

3. Butt vs. Bead-on-plate Characteristics. Figures 41 through 44 provide temperature distribution data for the tests with strain gages installed and Figures 45 through 51 provide data on transverse and longitudinal strain distributions resulting from these tests. Ideally, a butt weld becomes more and more like a bead-on-plate weld for multipass situations. One would hope for a two dimensional model which could cover both cases. Unfortunately, Figures 43 and 44 show a different initial temperature distribution for bead-on-plate and butt welds. This implies that for the plate thickness utilized in this study, the two types of weld will behave somewhat differently in the way of thermally-induced strains, moments, and distortions. The bead-on-plate weld is not a two dimensional situation, but the butt weld clearly is. Figures 45, 46, 48, and 49 seem to agree with this observation for strains, since bottom bead-on-plate values do not match the top ones. The higher transverse strains for Test No. 4 are noted, but not fully explained. The strains were eratic at their peak values as if the plate was slipping in its constraint.

4. Correlation Between Experiments. In general, there is not much correlation between residual strains from experiment to experiment. This problem has been noted at MIT with previous experiments and is again noted here in the various strain distributions. An effort to find a

means of correlation was made by looking at the angle between the largest principal strain and the x-axis (ϕ_x). This data is shown in Figures 52 through 55. There seems to be little correlation in the residual strain region other than that the major strains are either close to the x or the y axis. Along the edge of the panel, however, the test data consistently show a ϕ_x which implies loading by shear.

Figures 56 through 58 provide a much more successful means of correlation. The ratio of the invariant described in Equation (64) to the temperature dependent uniaxial yield stress from Table 5 is plotted with respect to time. For residual conditions, there appears to be very good correlation between the "state of stress" composed of all stress components from test to test. In addition, when the value of this ratio exceeds 1.0, a yielding situation exists, and plastic deformation occurs.

The static residual strain measurements made during this study offered such a wide and inconsistent variety of values that they were not included. One possible reason for this is that the position of the strain gages one inch away from the centerline of the plate may have been near the region in Figure 1-4, where the stress distribution went through a zero point with a large slope . Hence, a minor variation in stress could imply large positive or negative

variations in strain.

5. Extensiometer. The extensiometer results are plotted in Figure 59. Initial measurements vary from experiment to experiment because of the difficulty of placing the holding tabs in the exact same position. However, it is interesting to note that for the two situations presented here, once the weld was filled in the vicinity of the extensiometer, the extensions became a measurement of transverse shrinkage and were similar in both tests. Test No. 1 utilized two tack welds at the ends of the plate, and the arc became unstable as a result of metal movement in the center. All subsequent tests utilized four equally spaced tacks, so the plates were essentially rigid except in the immediate region of the arc.

B. Accuracy of the Experimental Model and Instrumentation:

1. The Physical Model. As mentioned previously, the plate geometry, level of constraint, and welding procedures are considered to be representative of ship fabrication processes. However, the means of constraining the panels is unsatisfactory because of evidence of slipping. Considerable difficulty was experienced in cementing the strain gages to the model. The best cement still remains

EPY-600 because it offers a lower curing temperature. However, pressure must be applied to the gage while the cement is curing, making this an extremely critical stage in model production.

2. <u>Data Reduction Calculations</u>. The temperature compensation has been previously discussed. However, in the strain distributions presented, there is a strange fluctuation in the results in the vicinity of the arc immediately before the thermal strains take off. It is of the opinion of this author that this is in part, if not all, due to temperature compensation techniques and represents only an "apparent strain". In any case, it is a minor effect and relatively unimportant.

3. <u>Instrumentation</u>. The Visacorder output was scaled initially in Test No. 4 to 1200 microstrain/inch and for later tests at 500 to 600 microstrain/inch. The reading accuracy is well within the 5% instrument accuracy estimated by technicians aiding in this study.

4. <u>Welding Machine</u>. The welding machine utilized in this study leaves much to be desired. The speed drive appears not to give a uniform arc velocity although the time to span the full plate length seems to be consistent. The voltmeter and ammeter on the power supply have never been calibrated and a clamp-on ammeter and separate

voltmeter had to be utilized as a result. The meters on the actual welding machine controls are either inoperative or way out of calibration. There is no screen over the tip of the torch which prevents back splatter from fouling the automatic filler metal feed system. Luckily, the wire jams which occurred as a result were on the starting tabs and the expensive test plates were not ruined.

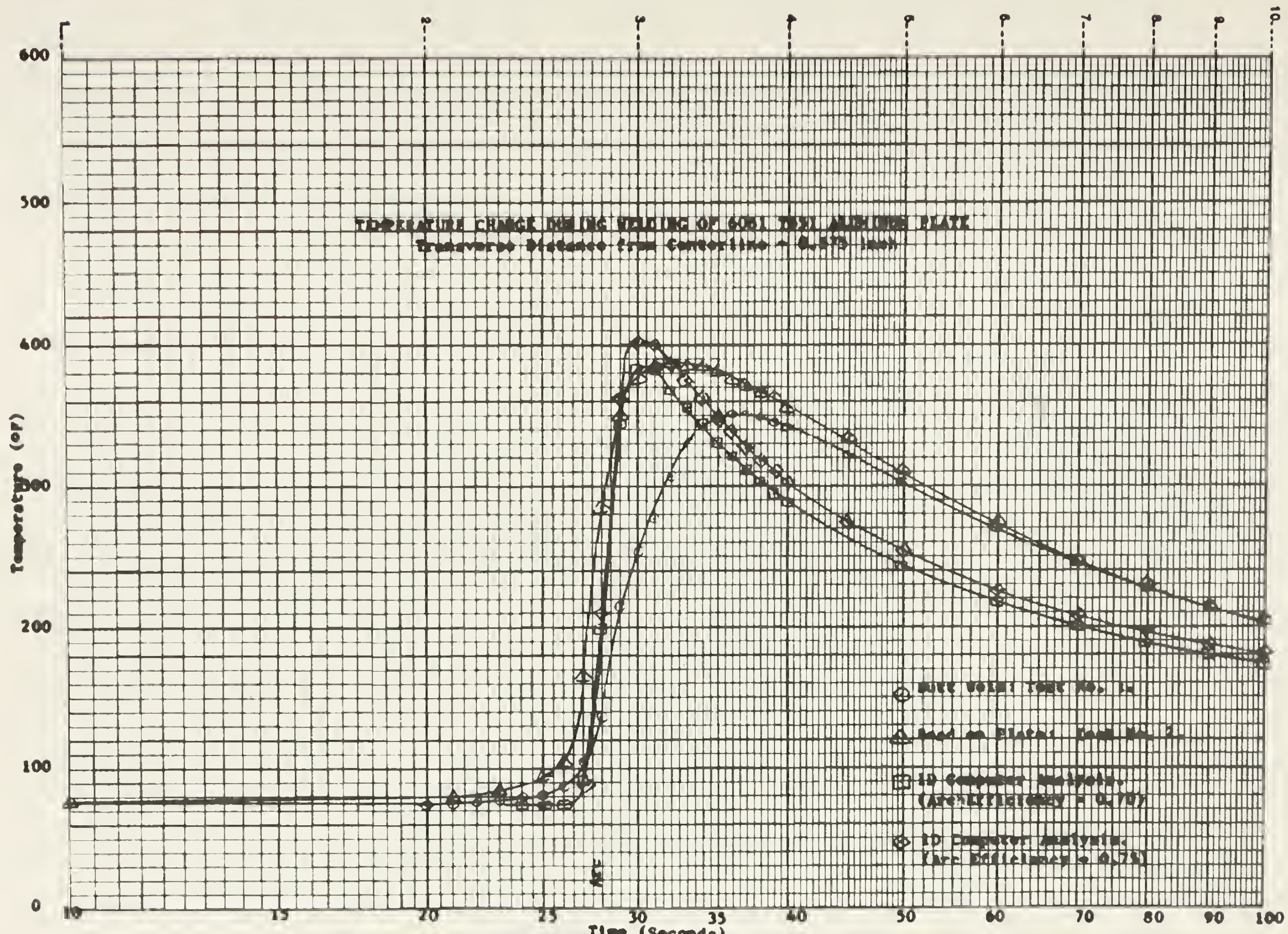


Figure 37: Temperature Distribution 0.675 Inch From Centerline.

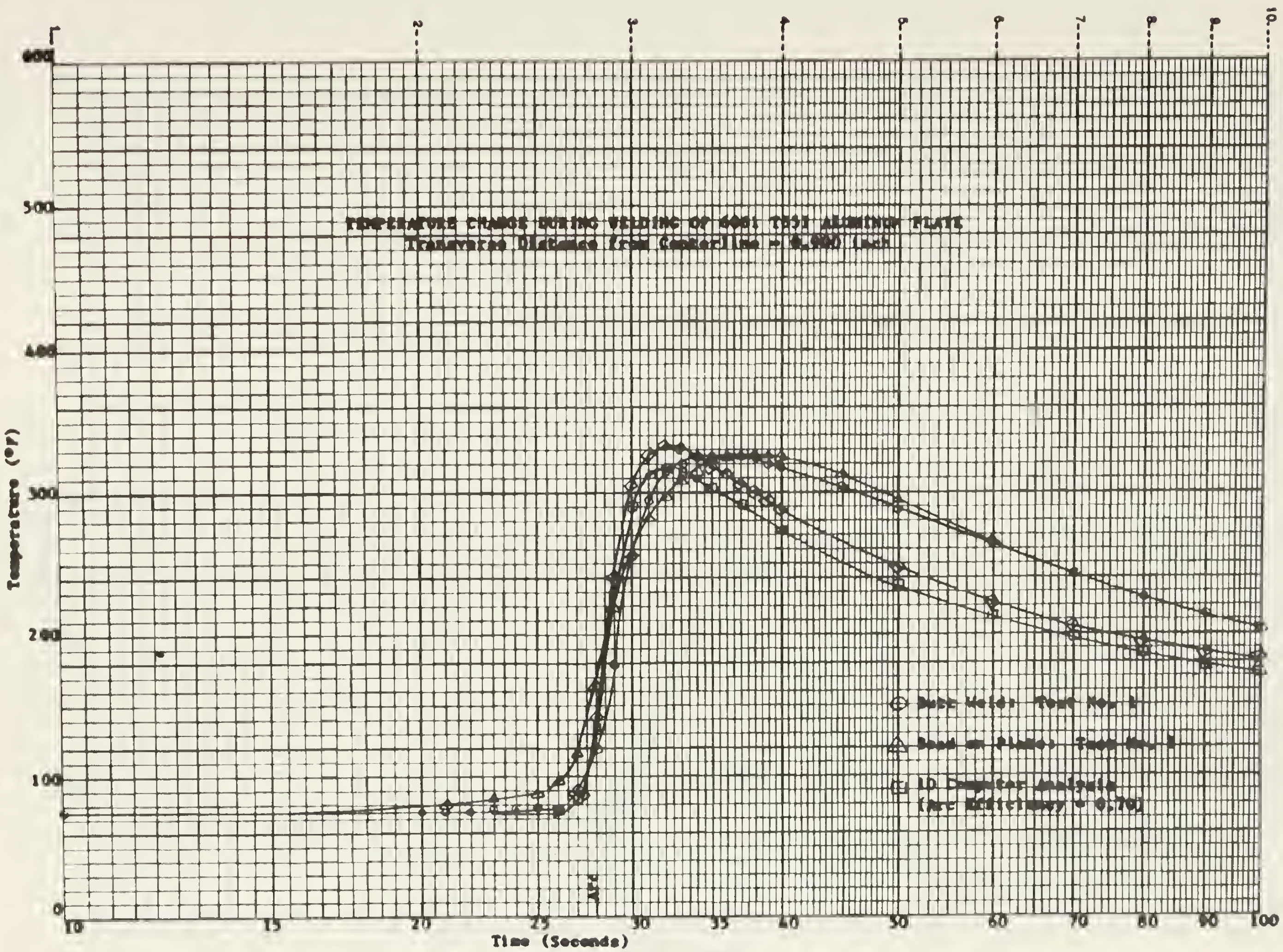


Figure 38: Temperature Distribution 0.900 Inch From Centerline.

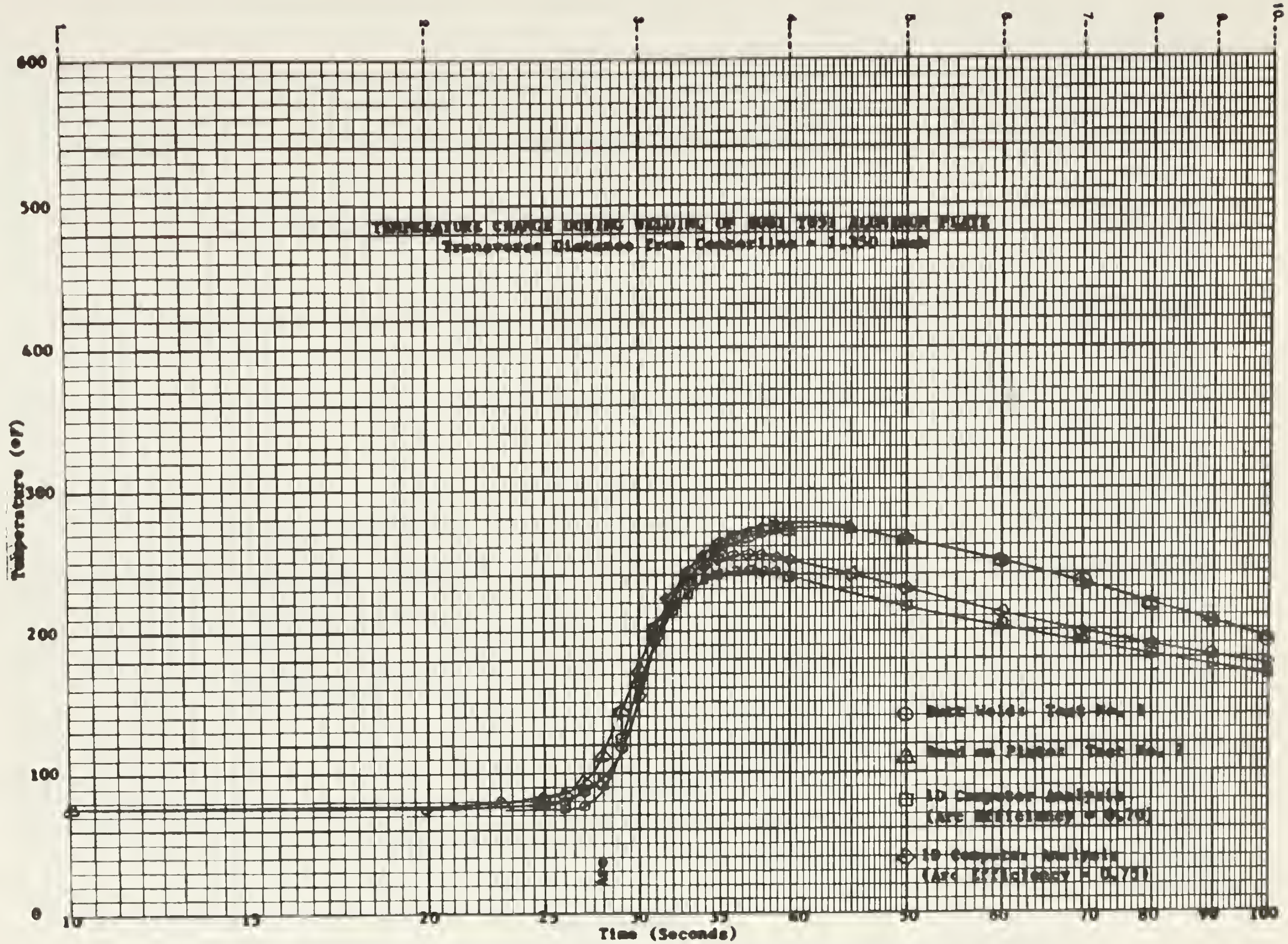


Figure 39: Temperature Distribution 1.350 Inch From Centerline.

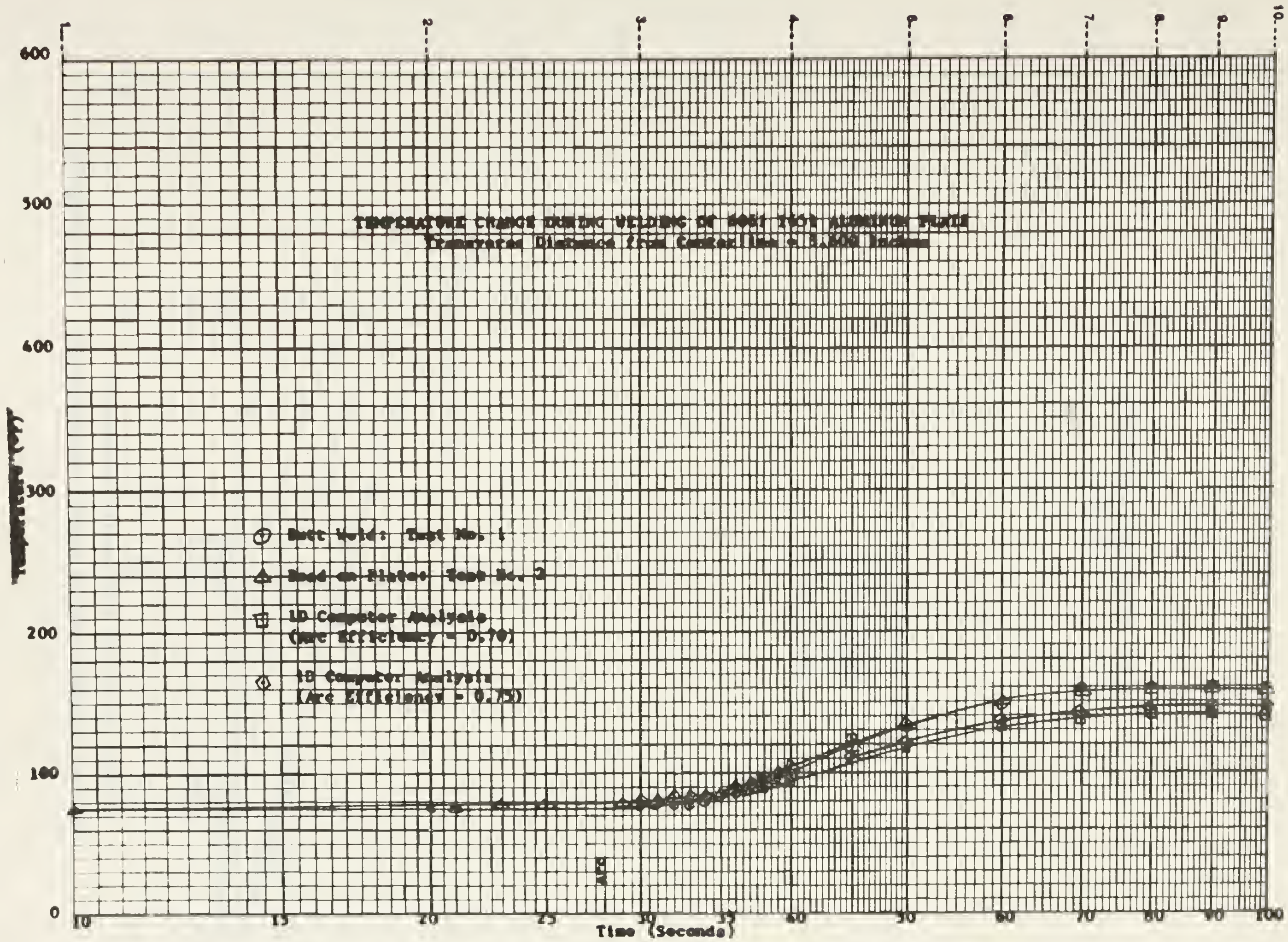


Figure 40: Temperature Distribution 3.600 Inches From Centerline.

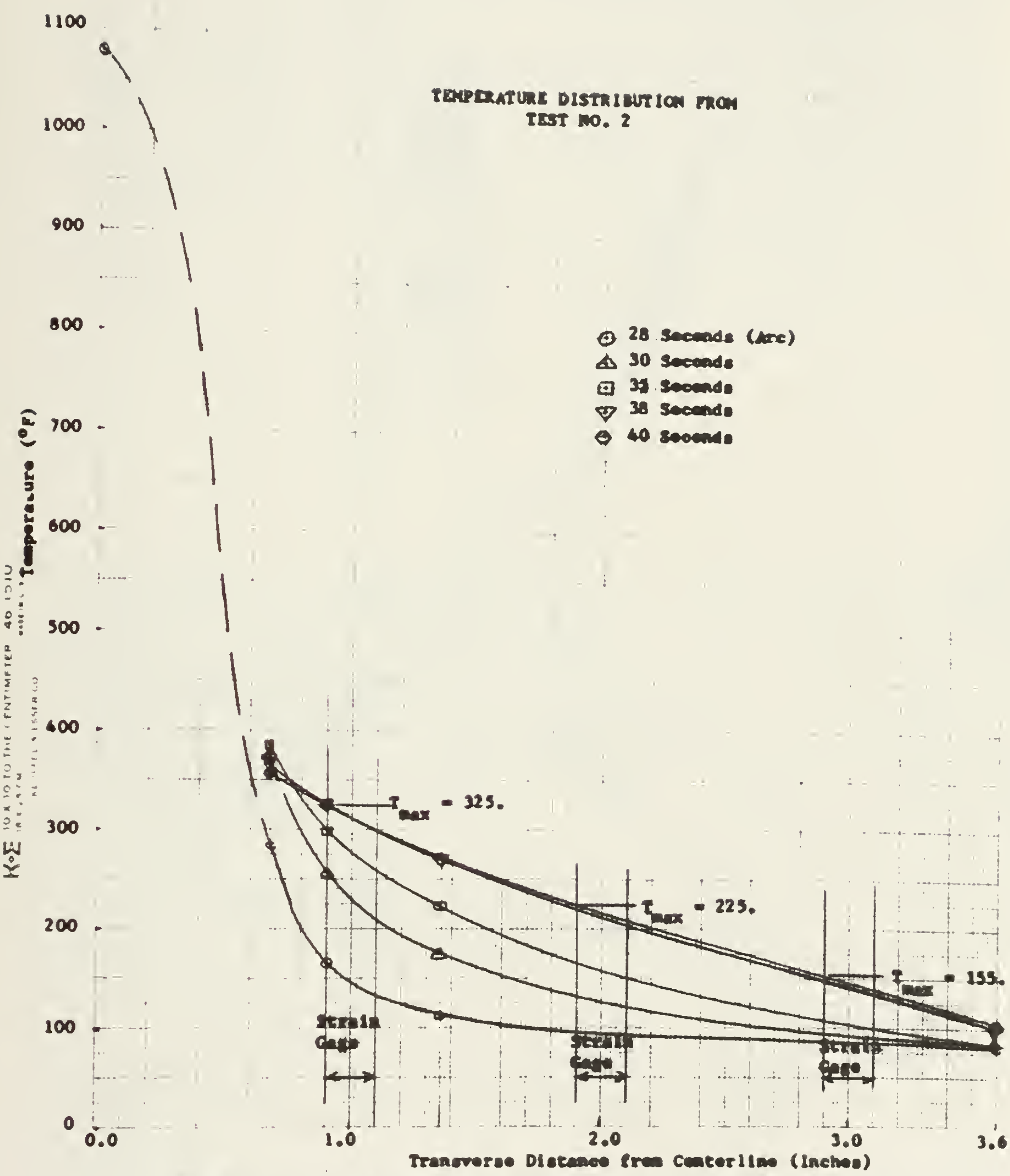


Figure 41: Transverse Temperature Distribution.

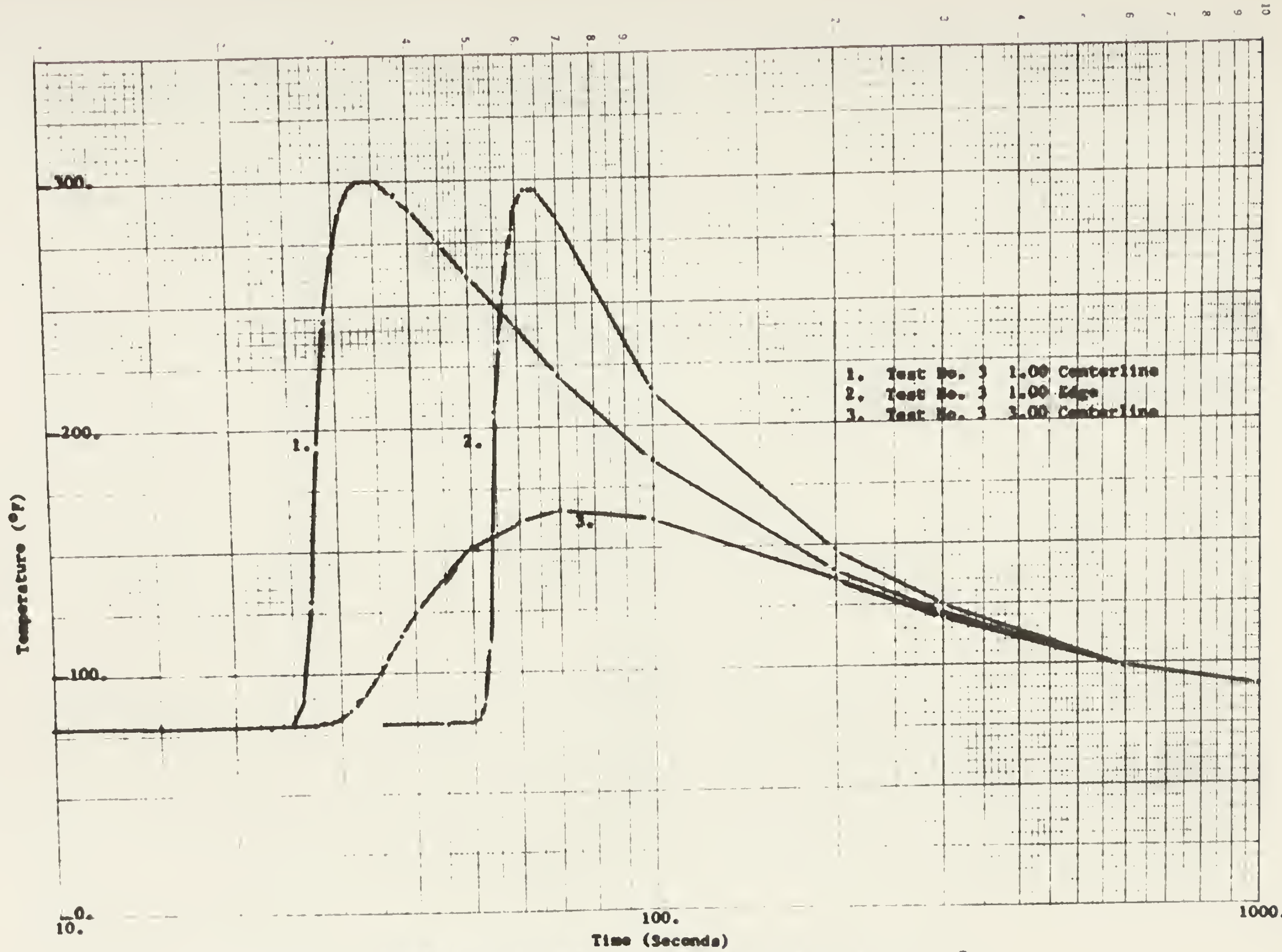


Figure 42: Temperature Distributions From Test No. 3.

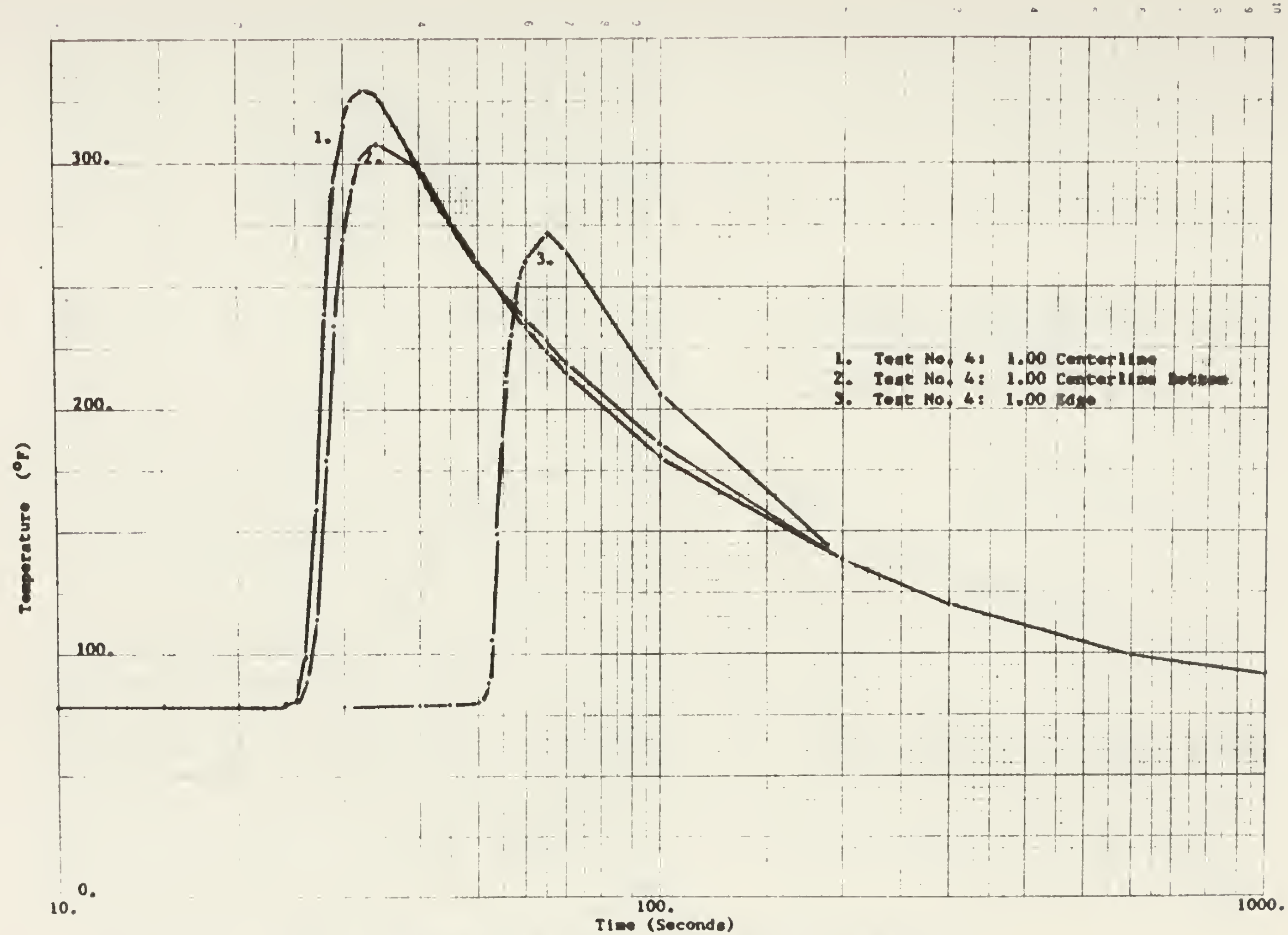


Figure 43: Temperature Distributions From Test No. 4.

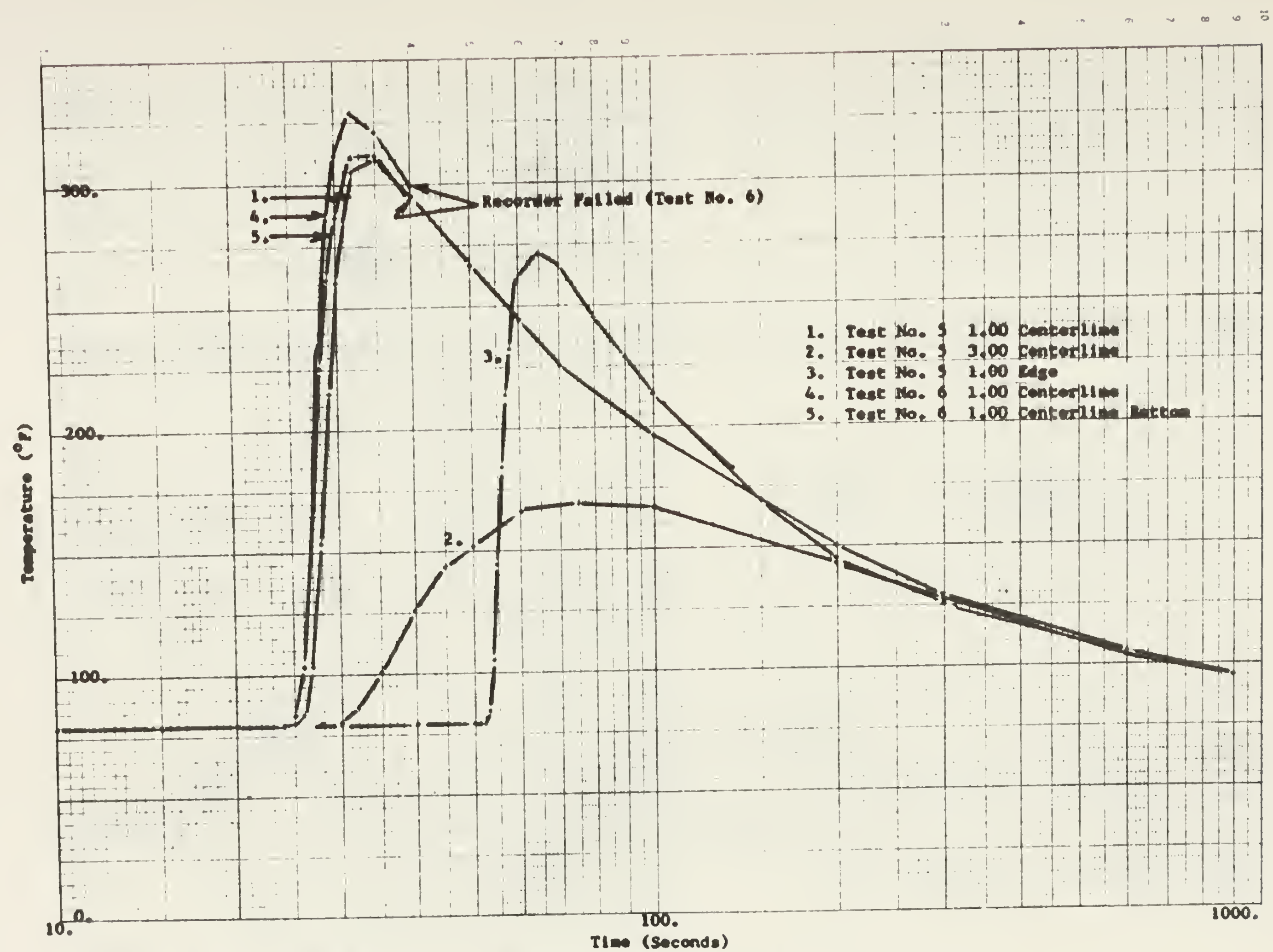


Figure 44: Temperature Distributions From Test No. 5 And 6.

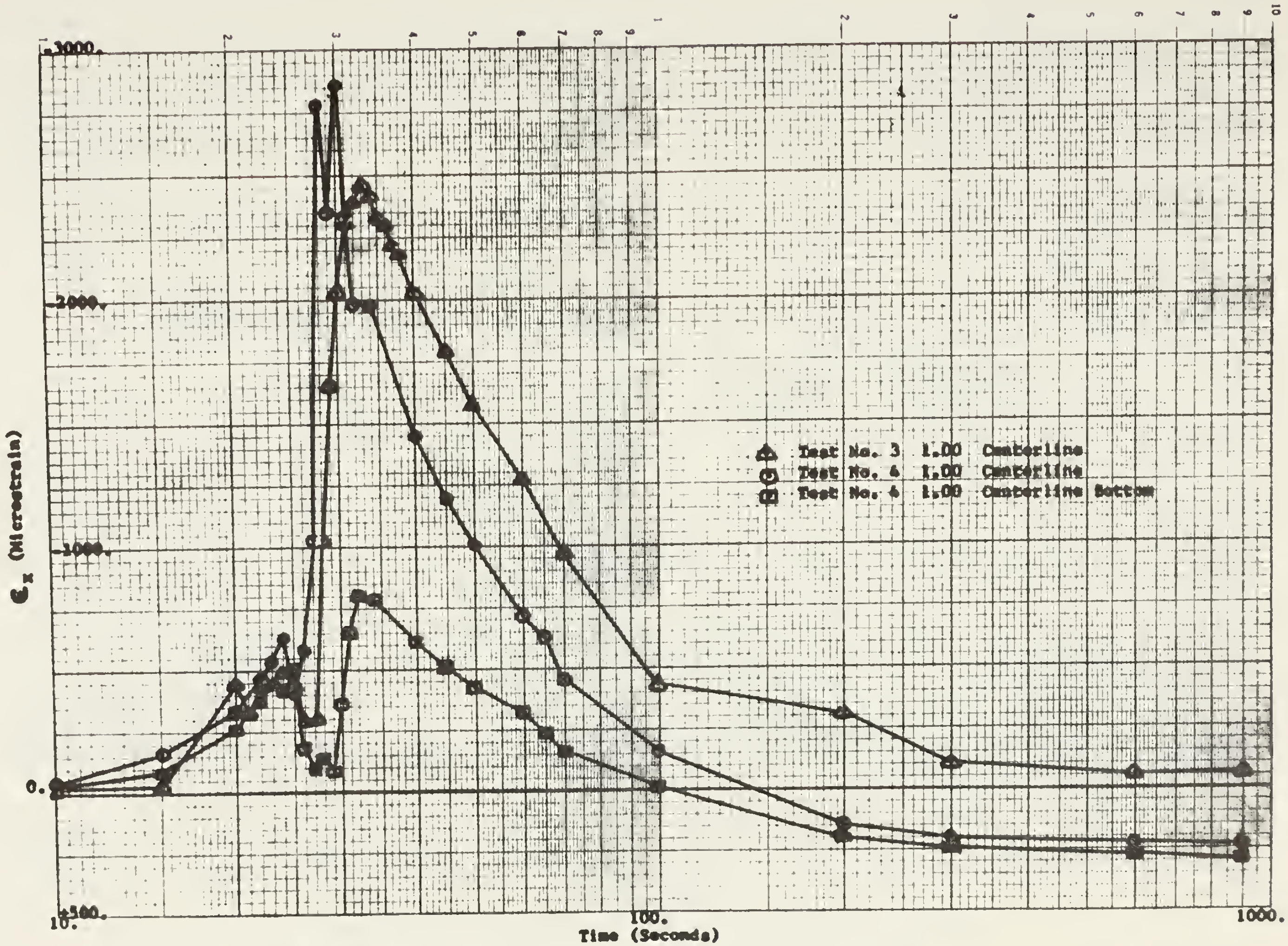


Figure 45: Longitudinal Strain Distributions.

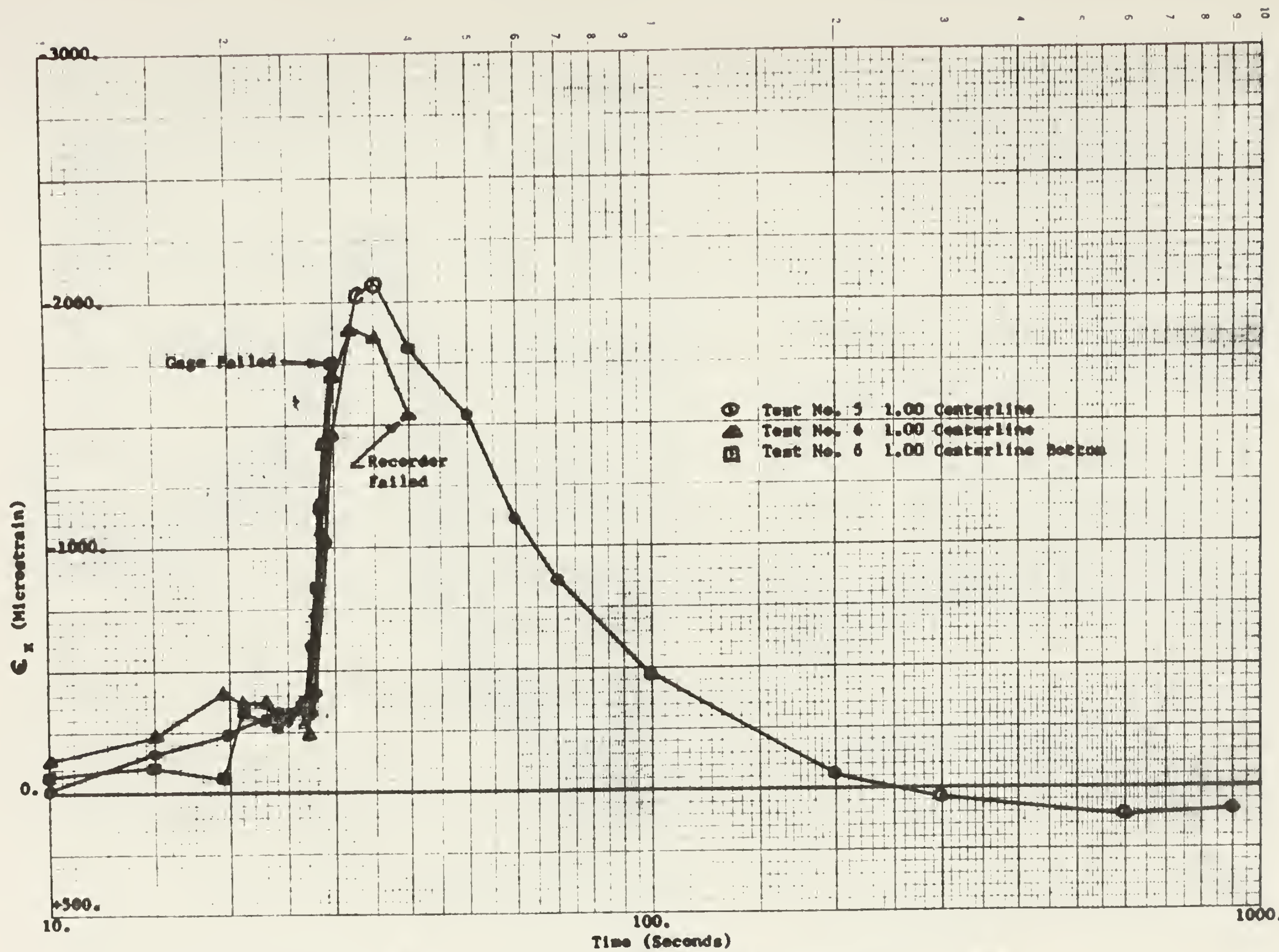


Figure 46: Longitudinal Strain Distributions.

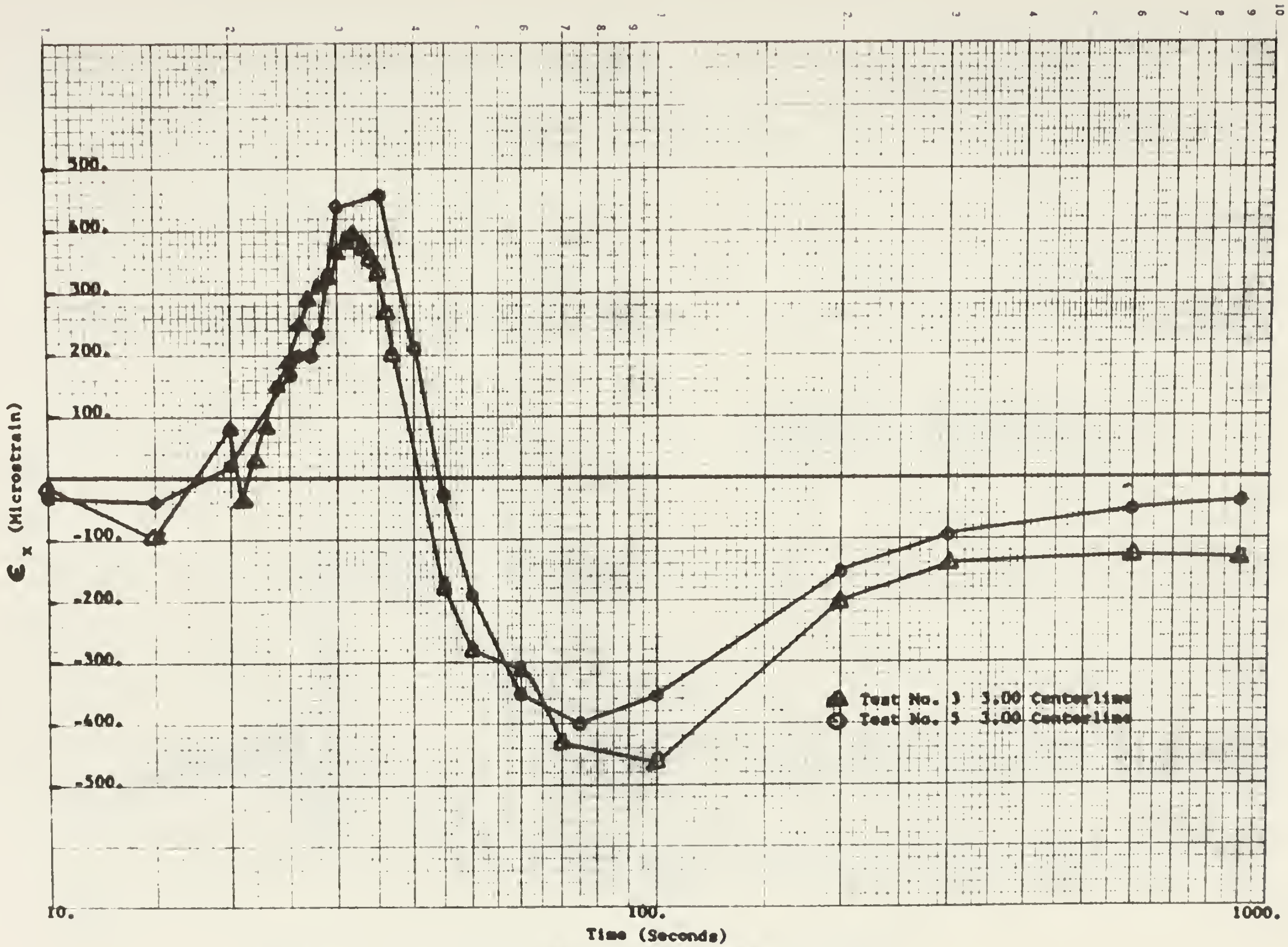


Figure 47: Longitudinal Strain Distributions.

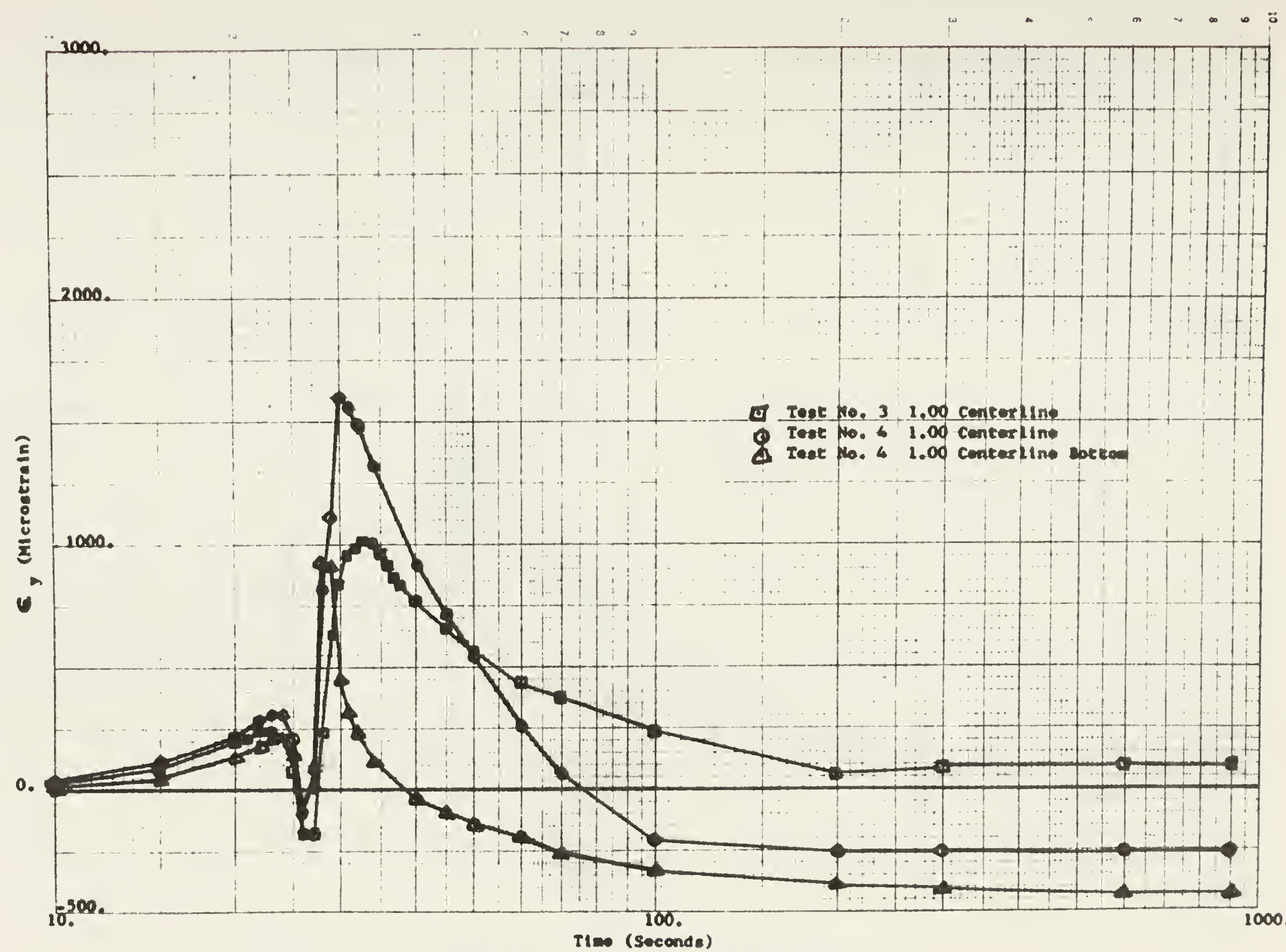


Figure 48: Transverse Strain Distributions.

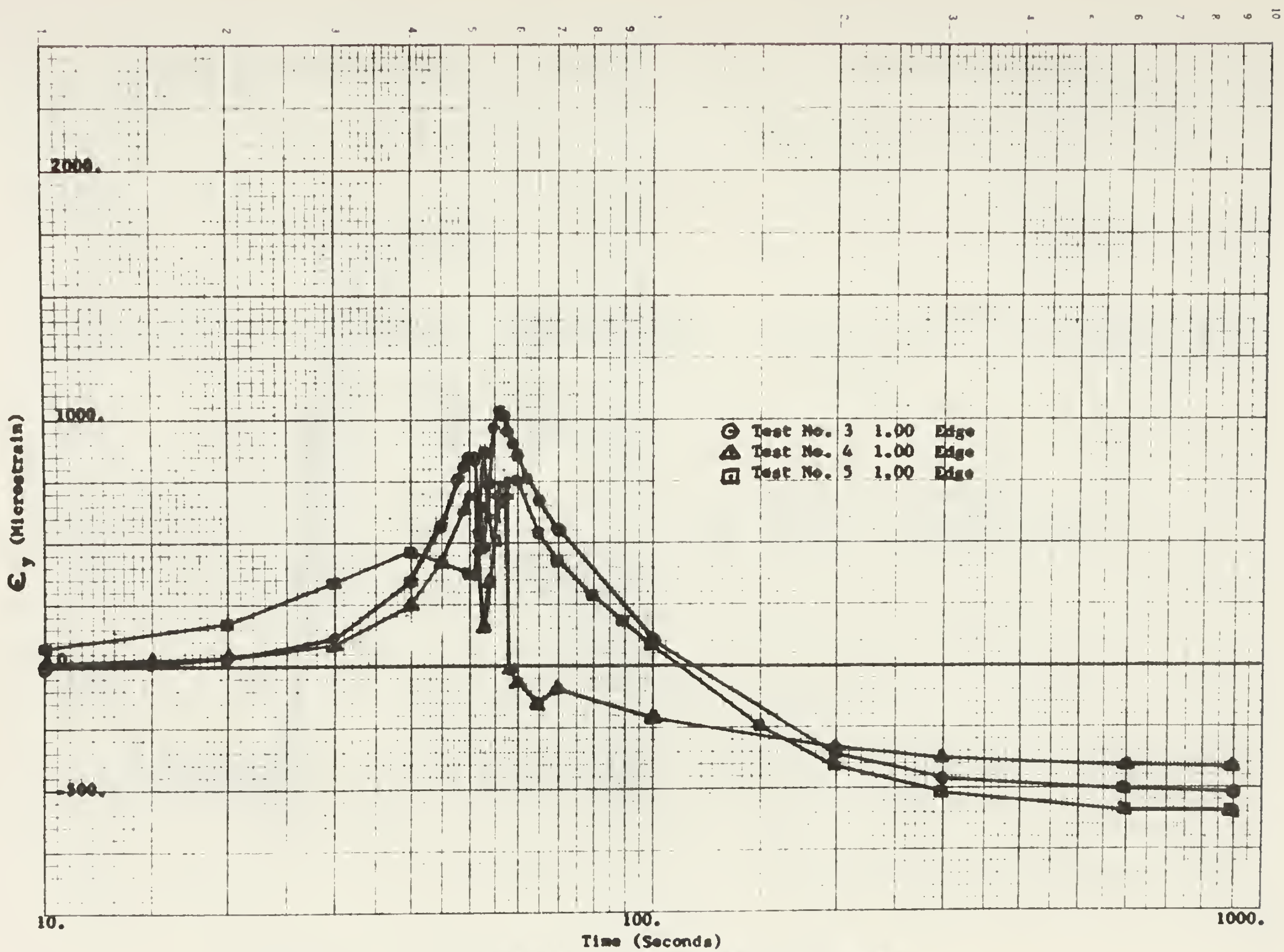


Figure 49: Transverse Strain Distributions.

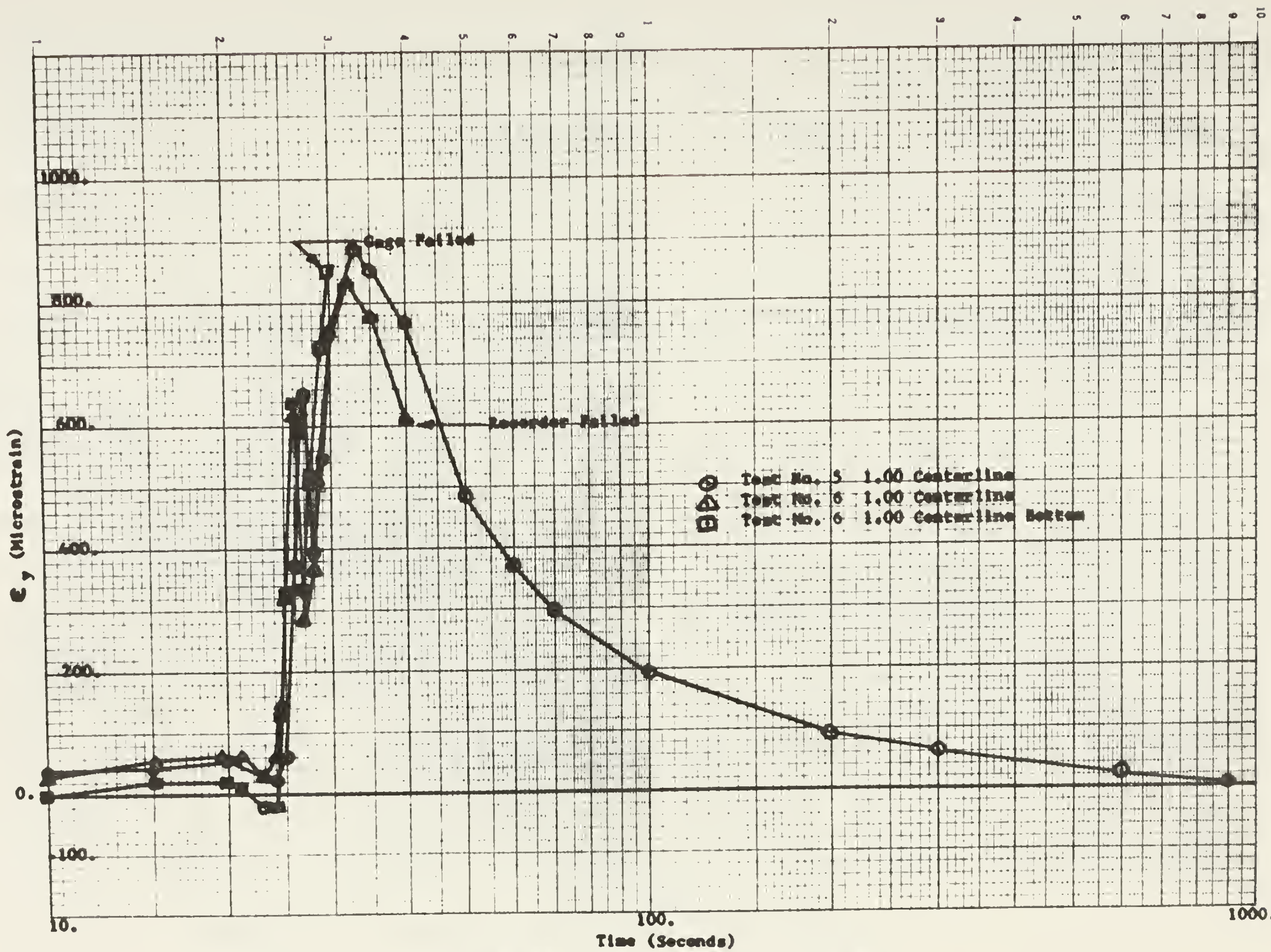


Figure 50: Transverse Strain Distributions.

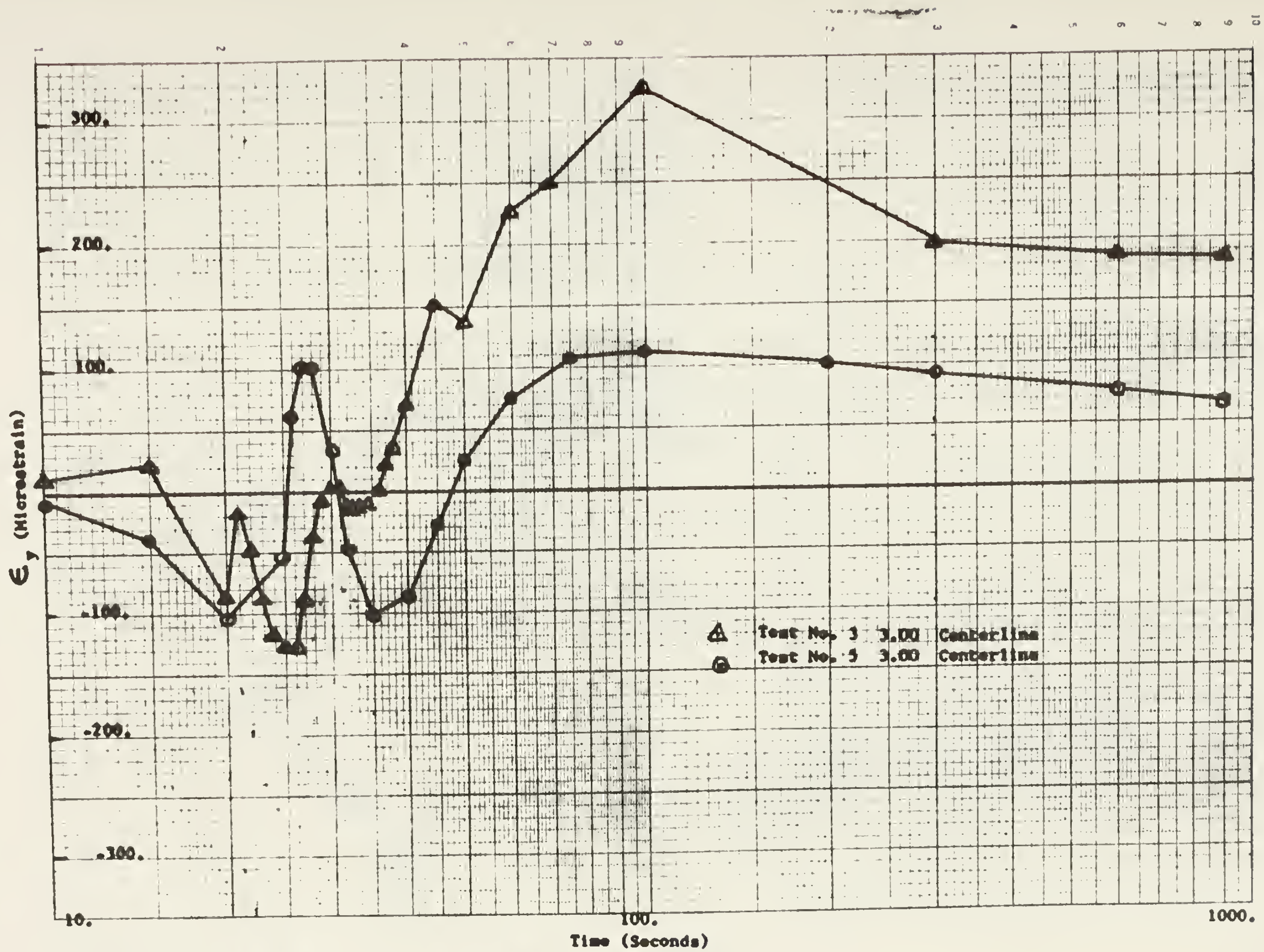


Figure 51: Transverse Strain Distributions.

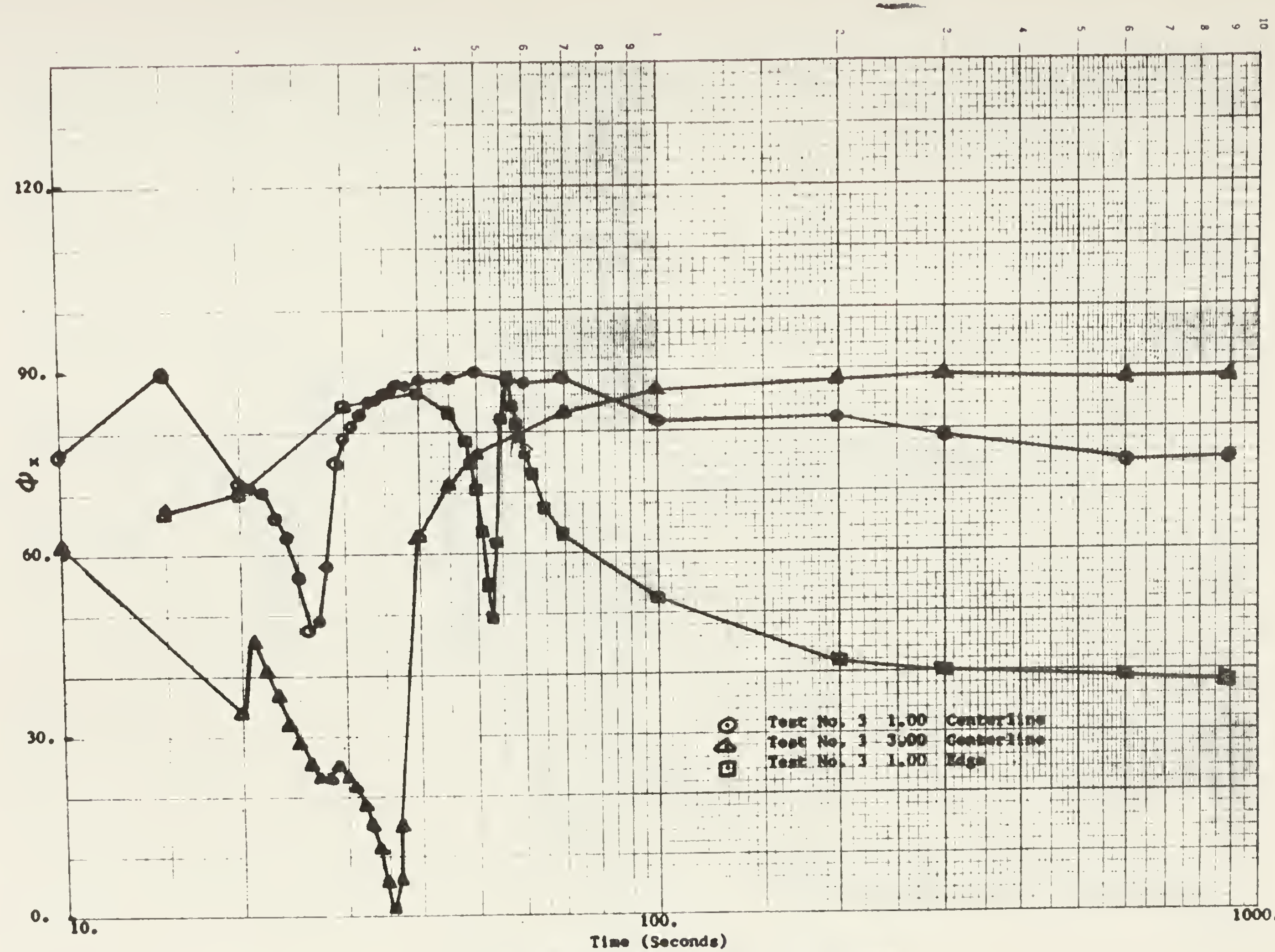


Figure 52: ϕ_x Distributions.

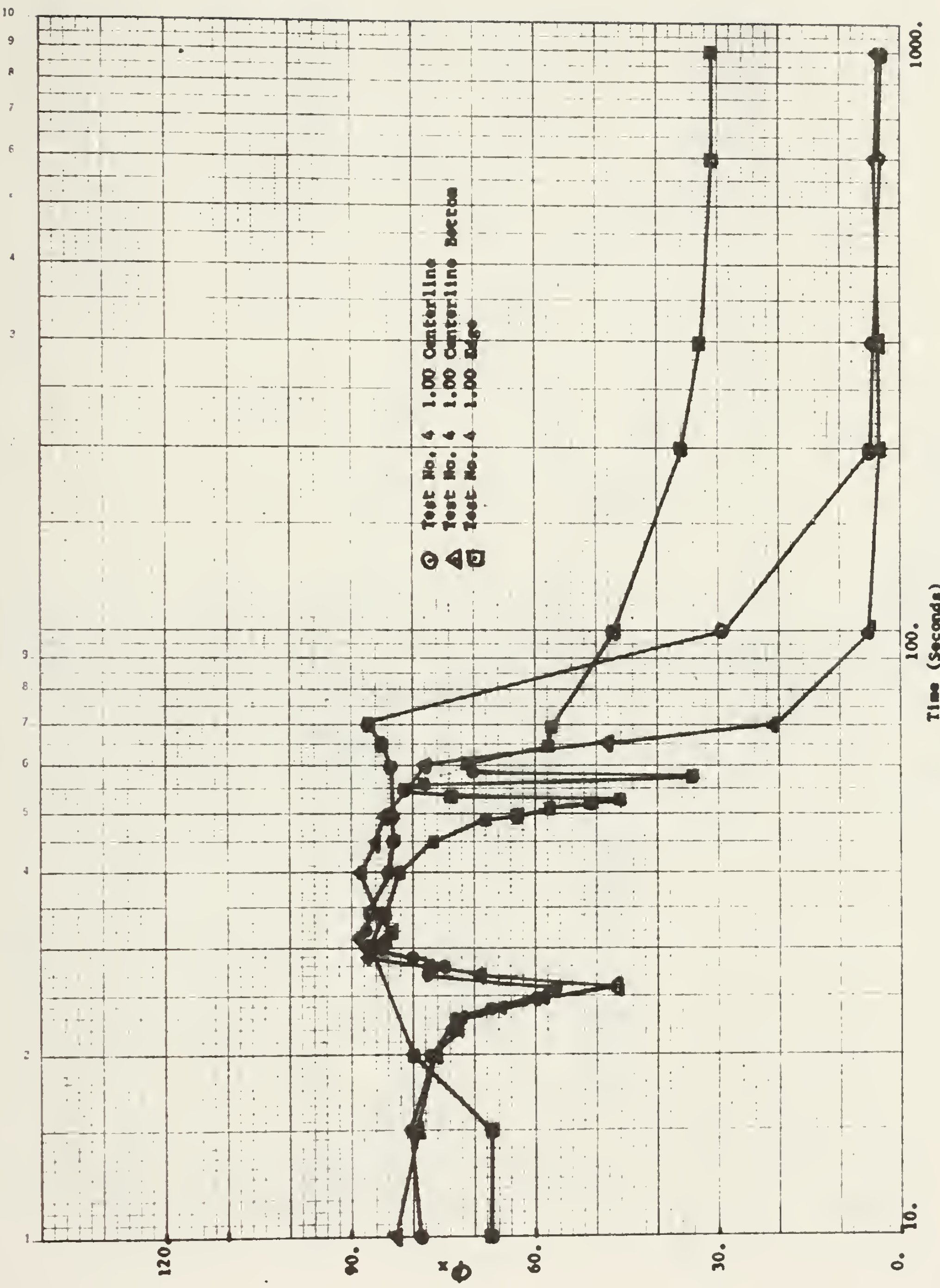


Figure 53: Φ_x Distributions.

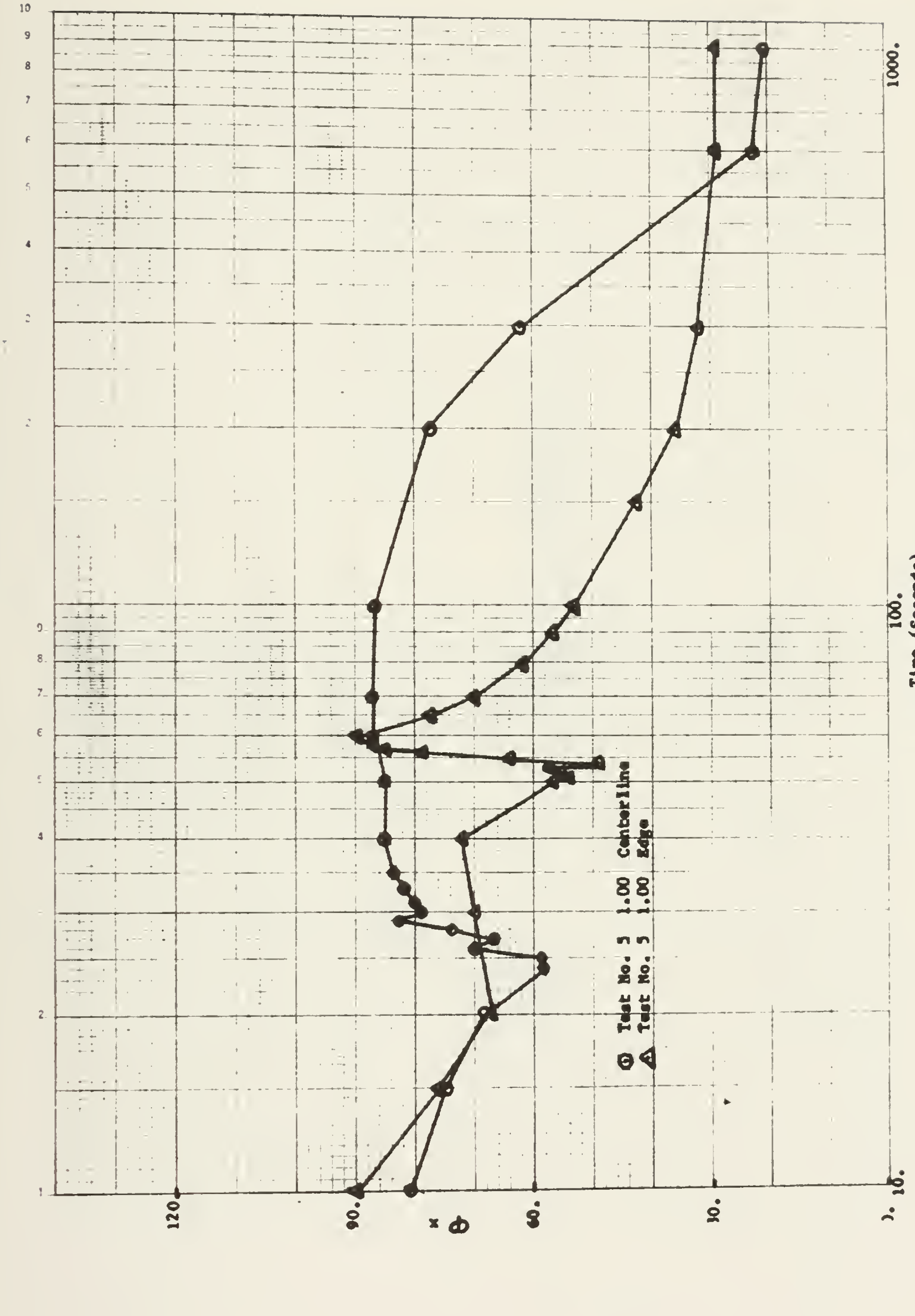


Figure 54: Φ_x Distributions.

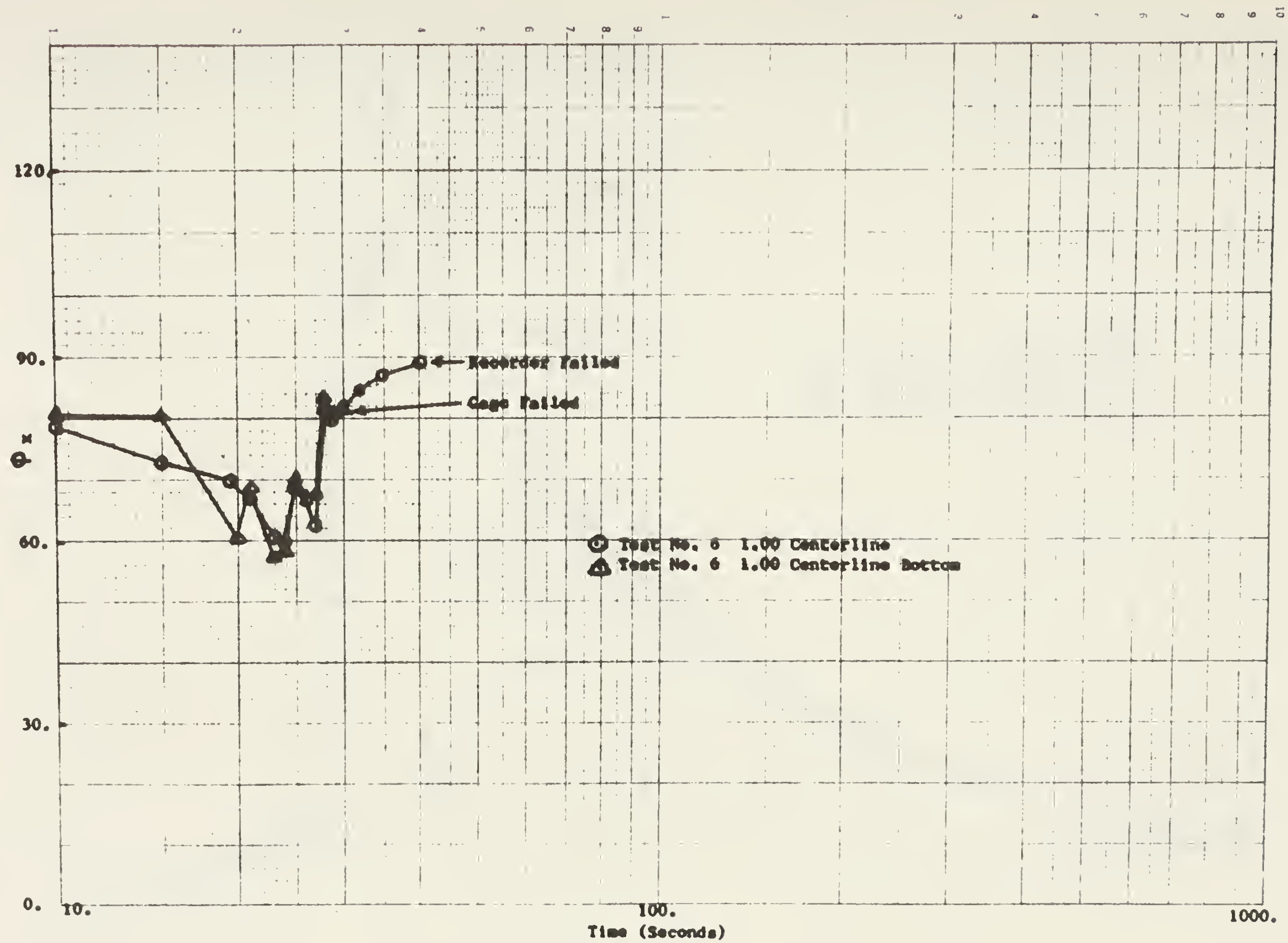


Figure 55: Φ_x Distributions.

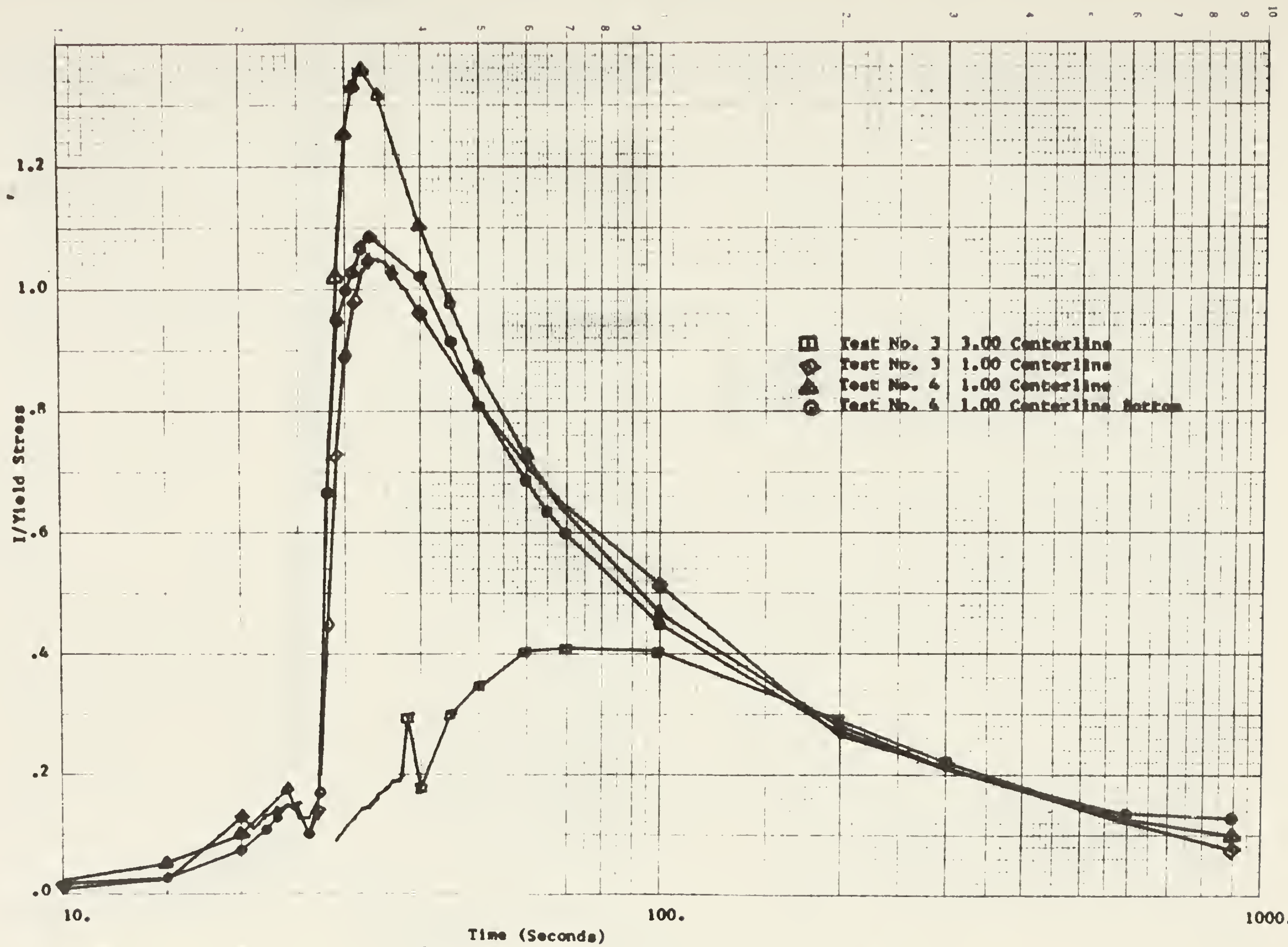


Figure 56: I / σ_y Distributions.

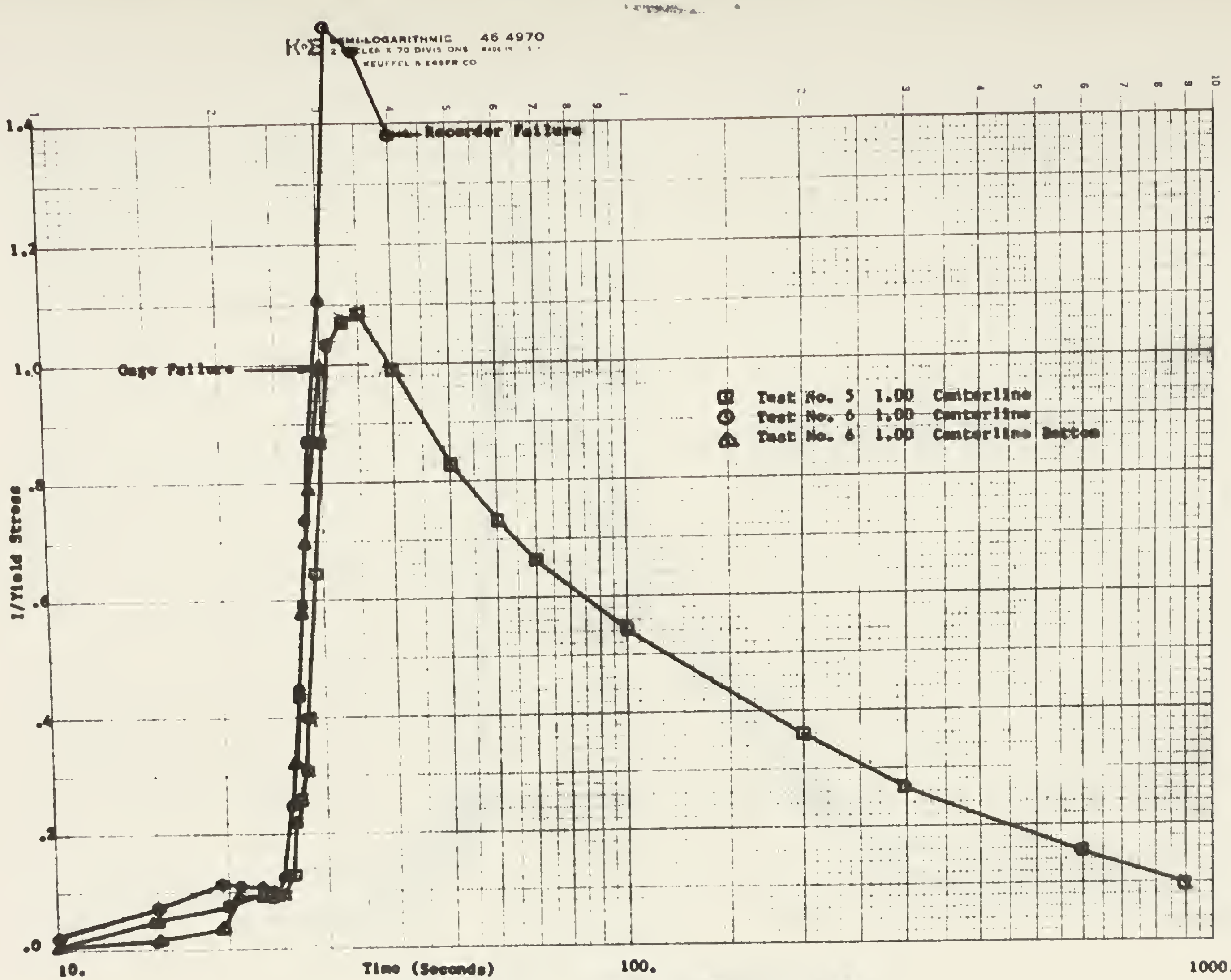


Figure 57: $1/\sigma_y$ Distributions.

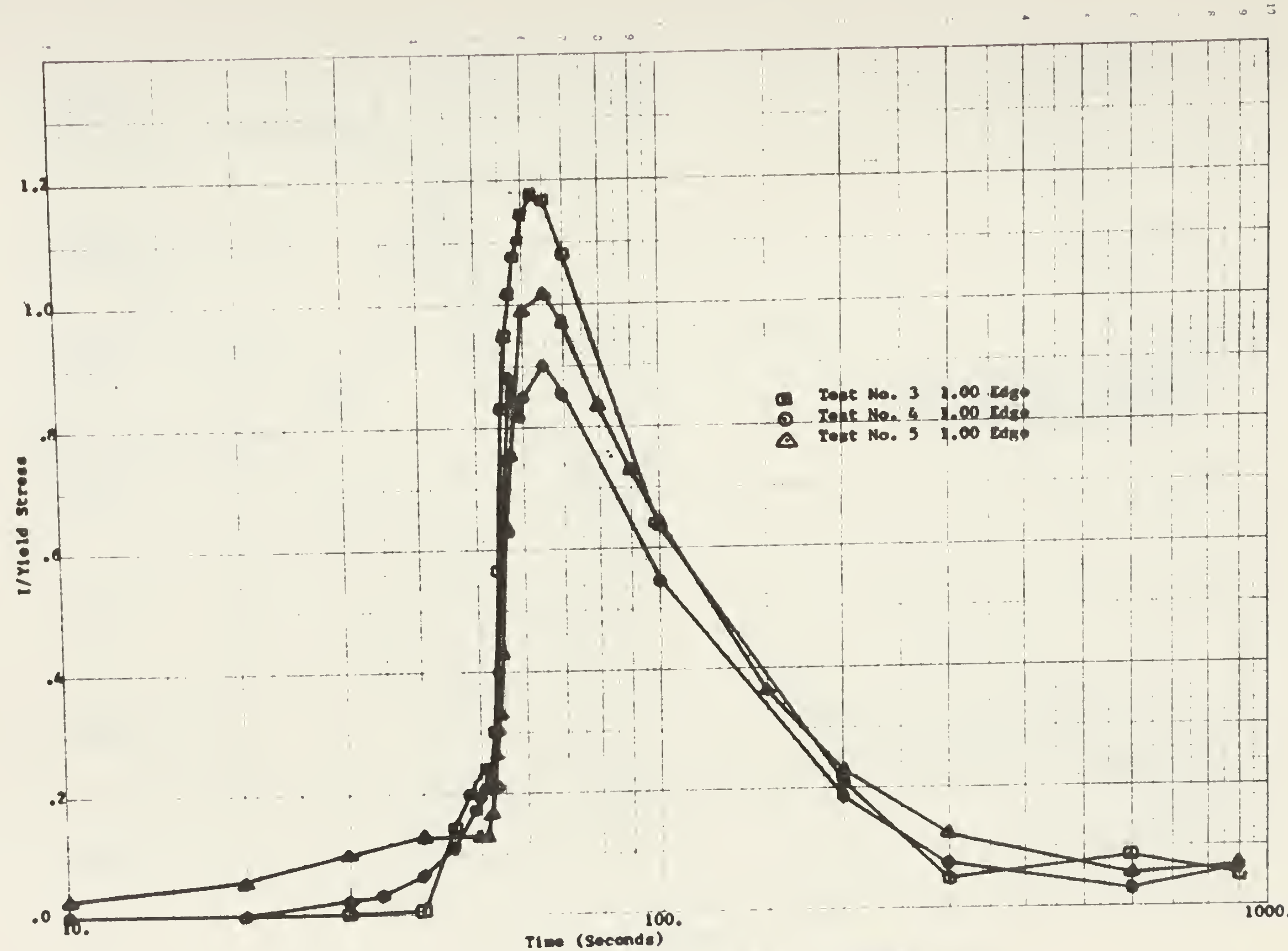


Figure 58: I / σ_y Distributions.

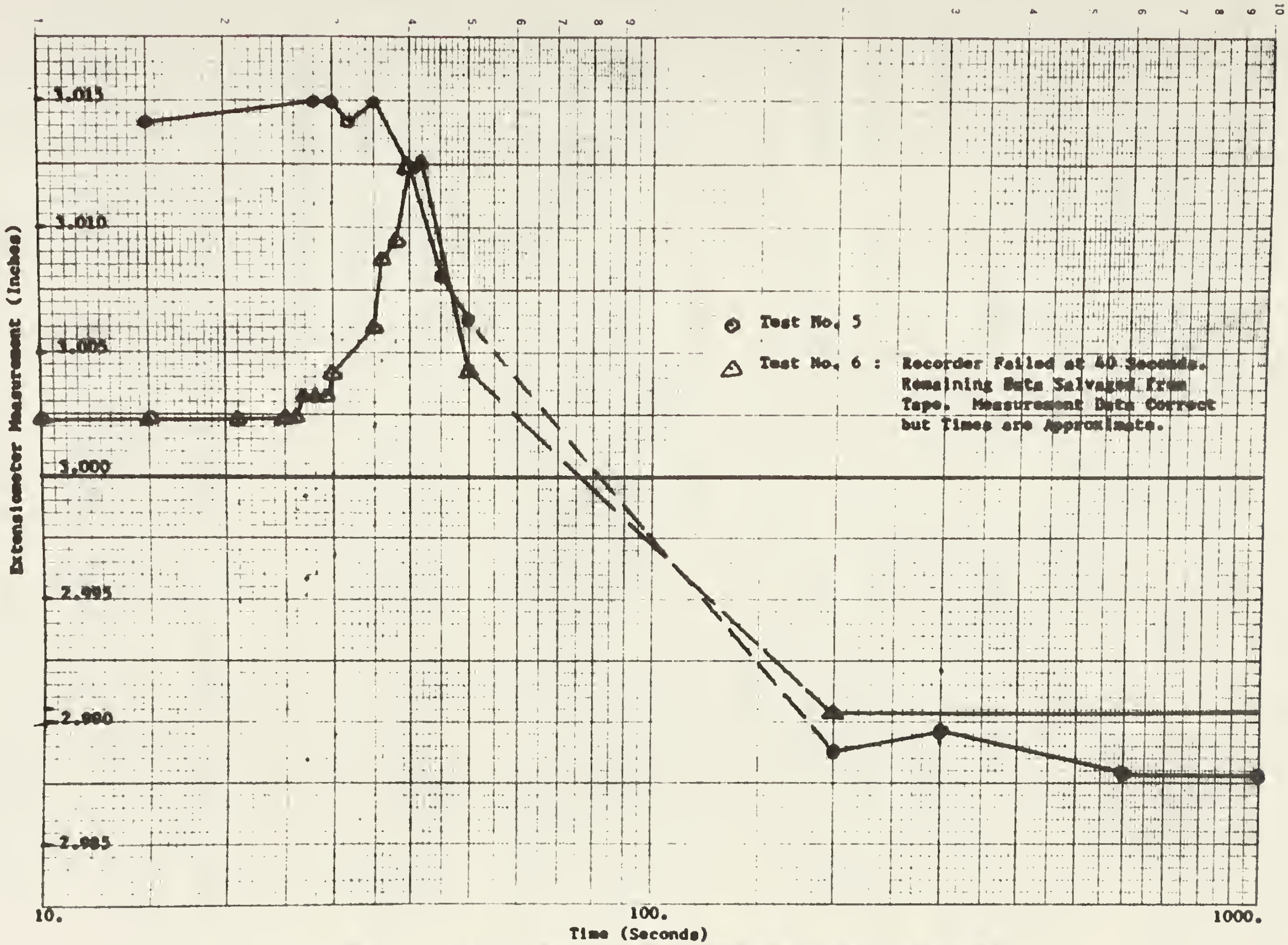


Figure 59: Butt Weld Extensiometer Measurements.

VI RECOMMENDATIONS:

1. The small number of tests performed in this study should be expanded into more tests, ultimately with plates of varying thicknesses. Data reduction from the Visa-corder strip charts is difficult and time-consuming. If a large number of test are run, it becomes almost imperative that some form of direct digital output be utilized to provide punched tapes or cards compatible with MIT's IBM computer system. Multipass tests likewise require this capability. Welding is a statistical process, so the larger the basis of data the better the results will be. Obviously, there are serious questions of financial and manpower resources available, so the trade-off of more experiments vs. better data must be seriously considered.

2. More bead-on-plate tests which record top and bottom strain and temperature distributions are needed to verify a two dimensional approximation.

3. The welding machine utilized by this study should be carefully inspected and the discrepancies noted in Chapter V remedied, or another machine must be found.

4. A "V" or "J" weld preparation should be considered for butt welding thicker plates.

5. Smaller strain gages should be utilized to allow easier application and closer positioning to the weld. This sacrifices the larger area for averaging measurements, however. Multiple-element gages should be of the stacked variety to eliminate time corrections for individual elements, and make data reduction simpler. Gages such as BLH Electronics' FABR-12-12SX13ET (stacked, three-element 45°, 0.12 inch gage length), FABX-12-12S13ET (stacked, two-element, 90°, 0.12 inch gage length), or FAER-06RB-S13ET (three-element, 45°, .0625 inch gage length) or equivalent Micro-Measurements, Inc. gages should be utilized.

6. If time permits, an independent check of apparent strain corrections is recommended to verify factory data. This may be accomplished by cementing a gage to a sample test plate and heating it in an oven.

7. High temperature strain gages should again be considered to see if they are any more reliable than reported previously by Klein (7).

8. The test plate mounting assembly should be modified to allow bolting vice clamping of the plate boundaries. This may be done simply by drilling and tapping the bed plate currently in use, and will eliminate any slipping from taking place.

9. Further use of the extensiometer is not recommended. It costs one channel on the Visacorder and causes the loss of a rosette (12 channels are available: 3 rosettes and 3 thermocouples, or 2 rosettes, 2 single-element gages, the extensiometer and 3 thermocouples). This author feels that there is more to be learned at present from the "state of stress" than from shrinkage measurements. However, if continued use of the extensiometer is desired, two more gages should be installed to double its sensitivity.

10. Continued basic research is needed to provide better physical and mechanical properties for a larger variety of structural materials.

APPENDIX A

```
// 'JON J. BRYAN',CLASS=L,REGION=128K
/*MITID USER=(M10004,8940,,,    )
/*SRT STANDARD
/*MAIN TIME=2,LINES=2,CARDS=2
//   EXEC WATFIV
//C.SYSIN DD *
$JOB              BRYAN,NOSUBCHK,LIBLIST,TIME=1,PAGES=20
C     CURVE FITTING PROGRAM UTILIZING A CUBIC POLYNOMIAL.
C     TABLES OF T, F(T) READ IN.
C     POLYNOMIAL COEFFICIENTS READ OUT IN E15.7 FORMAT.
      DIMENSION T(4),F(4),B(4),A(4,4),P(4)
      DO 999 L=1,13
      READ(5,100)T
      READ(5,100)F
 100  FORMAT(4F10.3)
      WRITE(6,95)
 95   FORMAT(20X,'TEMPERATURE FUNCTION TABLE OF ORIGINAL DATA
     1FOLLOWS:'//)
      WRITE(6,96)T
 96   FORMAT(5X,'TEMPERATURE',4X,4(F10.3,5X),//)
      WRITE(6,97)F
 97   FORMAT(5X,'FUNCTION F(T)',2X,4(F10.3,5X),//)
      DO 1 J=1,4
      X=T(J)
      A(J,1)=1.0
      A(J,2)=X
      A(J,3)=X**2
      A(J,4)=X**3
 1    CONTINUE
C     COEFFICIENT MATRIX A(I,J) NOW ESTABLISHED.
      B(1)=F(1)
      B(2)=F(2)
      B(3)=F(3)
      B(4)=F(4)
      CALL SIMQ(A,B,4,KS)
C     SOLUTION VECTOR READ OUT AS B BY SIMQ. ORIGINAL A DESTROYED.
```

```
C      SIMQ VALUE KS:  0 IMPLIES NORMAL SOLUTION; 1 IMPLIES SINGULAR SET
C      OF EQUATIONS.
       WRITE(6,98)
 98    FORMAT(5X,'SIMQ VALUE KS=0 IMPLIES NORMAL SOLUTION.  KS=1 IMPLIES
      1SINGULAR SET OF EQUATIONS.',///)
       WRITE(6,99) KS
 99    FORMAT(5X,'SIMQ VALUE KS = ',I3///)
       WRITE(6,101)
 101   FORMAT(5X,'P(T)=A(0) + A(1)*T + ............ +A(3)*T**3',////)
       DO 2 J=1,4
       K=J-1
       WRITE(6,102) K,B(J)
 102   FORMAT(5X,'A(',I3,')=',5X,E15.7//)
 2     CONTINUE
       WRITE(7,103)B
 103   FORMAT(4E15.7)
 999   CONTINUE
       CALL EXIT
       END
$ENTRY
0.0         77.0        300.0       500.0
40.5        40.0        36.0        22.0
500.0       700.0       1000.0      1080.0
22.0        5.0         0.5         0.0
0.0         77.0        500.0       1080.0
10.2        10.0        7.65        0.0
0.0         400.0       800.0       1080.0
10.2        3.57        4.60        0.0
0.0         77.0        600.0       1080.0
0.752       0.740       0.507       0.000
77.0        400.0       700.0       1080.0
0.752       0.656       0.427       0.0
0.0         100.0       300.0       500.0
12.19       15.55       14.26       15.31
500.0       750.0       950.0       1080.0
15.51       16.43       17.75       19.32
```

```
0.0       200.0     400.0     600.0
12.41     13.17     13.77     14.26
600.0     750.0     900.0     1080.0
14.20     14.59     14.97     15.50
0.0       100.0     200.0     300.0
9.80      9.754     9.685     9.646
0.0       100.0     300.0     500.0
2.161     2.254     2.402     2.522
500.0     700.0     900.0     1080.0
2.522     2.645     2.765     2.943
$STOP
/*
```

```
// 'JOB J. BRYAN',CLASS=I,REGION=128K
/*MITID USER=(M10004,0940,,,    )
/*SRT STANDARD
/*MAIN TIME=2,LINES=5
//   EXEC WATFIV
//C.SYSIN DD *
$JOB              BRYAN,TIME=1
C       FUNCTION GENERATOR TO TEST POLYNOMIAL COEFFICIENTS.
C       TEST RUNS FROM 0 TO 1080 DEGREES FAHRENHEIT.
C       COEFFICIENTS READ IN WITH 4E15.7 FORMAT.
        DIMENSION B(4),T(110),P(110)
        DO 999 L=1,13
        READ(5,100)B
 100    FORMAT(4E15.7)
        WRITE(6,103)
 103    FORMAT(30X,'TEMPERATURE FUNCTION TABLE FOLLOWS:'//)
        DO 1 J=1,109
        T(J)=(J-1)*10.
        X=T(J)
        P(J)=B(1)+B(2)*X+B(3)*X**2+B(4)*X**3
        WRITE(6,106) T(J),P(J)
 106    FORMAT(5X,'IF T = ',F10.3,5X,'THEN F(T) APPROXIMATED =',F10.3/)
 1      CONTINUE
 999    CONTINUE
        CALL EXIT
        END
$ENTRY
   0.4050000E 02 -0.7480200E-02  0.2589436E-04 -0.1698679E-06
   0.1840897E 03 -0.5056120E 00  0.5837074E-03 -0.2016852E-06
   0.1020000E 02 -0.2337847E-02 -0.3124401E-05 -0.3199794E-08
   0.1020000E 02 -0.1817137E-02 -0.4810746E-05 -0.2084789E-08
   0.7520000E 00 -0.1240664E-03 -0.4030978E-06 -0.1108005E-09
   0.7548185E 03 -0.1320357E-03 -0.4405592E-06 -0.0592[illegible]E-10
   0.1219000E 02  0.9404994E-02 -0.1109993E-04  0.1049908E-07
   0.1409139E 02 -0.6089211E-03  0.7212205E-05 -0.2243020E-08
   0.1241000E 02  0.4263324E-02 -0.[illegible]24347E-05  0.1041597E-0[illegible]
```

```
  0.15520530E 02   0.1167117E-02   0.4706676E-06   0.2805547E-09
  0.98000000E 01  -0.7065365E-03   0.1200053E-05  -0.1166804E-08
  0.21010000E 01   0.1197628E-02  -0.1859963E-05   0.1616616E-08
  0.20189540E 01   0.1561132E-02  -0.1553752E-05   0.7874967E-09
$STOP
/*
```

APPENDIX B

```
// 'JON J. BRYAN',CLASS=B,REGION=128K
/*MITID USER=(M10004,8940,,,    )
/*SRT STANDARD
/*MAIN TIME=2,LINES=5
/*FORMAT PR,DDNAME=FT06F001,FORMS=THESIS,OVFL=ON,COPIES=2
//   EXEC WATFIV
//C.SYSIN DD *
$JOB              BRYAN,TIME=1,PAGES=20
C      DATA REDUCTION COMPUTATION
C      WELDING STRAIN-TEMPERATURE VARIATION: EXPERIMENATAL RESULTS.
C      INPUT CARDS TO THIS PROGRAM ARE:
C      CARD 1: NUMBER OF GAGES, VOLTS, AMPS (I5,2F6.0)
C      CARD 2:  COEFFICIENTS FOR COEFFICIENT OF THERMAL EXPANSION
C      POLYNOMIAL (4E15.7)
C      CARD 3:  COEFFICIENTS FOR YOUNG'S MODULUS POLYNOMIAL (4F15.7).
C      CARD 4:  COEFFICIENTS FOR YIELD STRESS (4F15.7).
C      CARD 5:  POISSON'S RATIO (F10.3)
C      CARD 6: STRAIN DATA: TIME; TEMP GAGE 1, TEMP GAGE 2, TEMP GAGE 3;
C              STRAIN, GAGE 1, LEG A, B, C; GAGE 2, LEG A,B, C;
C              GAGE 3, LEG A, B, C. (F8.0, 12F6.2)
C      CARD 7,8,9 ETC.  SAME TYPE OF DATA AS CARD 6.
C      UNITS:  COEFFICIENT OF THERMAL EXPANSION:  MICROSTRAIN/DEGREE
C      FAHRENHEIT;  YOUNGS MODULUS:  PSI; YIELD STRESS: KSI; STRAINS:
C      MICROSTRAIN.
       REAL NU
       INTEGER GAGE
       DIMENSION T(99),SZERO(99,3),STRN(99,3),S(99,3)
       DIMENSION EX(99),EY(99),GXY(99),E1(99),E2(99)
       DIMENSION PHIX(99)
       DIMENSION A(4),E(4),Y(4),ETHO(3), SIGX(3),SIGY(3),TAUXY(3),X4(3)
       DIMENSION Y1(3),X5(3)
       READ(5,90)GAGE,VOLTS,AMPS
 90    FORMAT(I5,2F6.0)
       J=GAGE
       WRITE(6,100)
 100   FORMAT(13X,'WELDING STRAIN ROSETTE DATA: EXPERIMENTAL RESULTS'/
```

```
     15X,'************************************************************
     2*'///)
      WRITE(6,101)
101   FORMAT(18X,'TEST NUMBER 4:  BEAD-ON-PLATE'/)
      WRITE(6,110)VOLTS,AMPS
110   FORMAT(18X,'ALUMINUM ALLOY 6061 IN T651 CONDITION'/18X,'THICKNESS
     1= 0.250 INCHES'/18X,'GMA WELD PROCESS'/18X,'ARC VOLTAGE = ',F6.0/
     2 18X,'AMPERES = ',F6.0/18X'SPEED OF TRAVEL = 32.16 INCHES/MINUTE')
      WRITE(6,111)
111   FORMAT(18X,'4043 FILLER METAL:  0.0625 INCH DIAMETER'/18X,
     2'UNITS OF STRAIN = MICROSTRAIN'//)
      WRITE(6,112)
112   FORMAT(33X,'CAUTION',//18X,'TEMP = 0.00 COMPUTATIONS REPRESENT'/
     218X,'BLANK SPACES ON INPUT CARDS AND ARE'/18X,
     3'MEANINGLESS.  IGNORE ALL SUCH COMPUTATIONS.'///)
      WRITE(6,120)
120   FORMAT(28X,'TRANSVERSE DISTANCE FROM WELD IN INCHES'//
     210X,'TIME',18X,'1.00',12X,'1.00',12X,'1.00'/
     38X,'(SECONDS)',11X,'(CENTERLINE)',4X,'(BOTTOM C/L)',
     46X,'(EDGE)'////)
      READ(5,91)A
      READ(5,91)E
      READ(5,91)Y
91    FORMAT(4F15.7)
      READ(5,92)NU
92    FORMAT(F10.3)
C     READ IN ROSETTE DATA: TIME, TEMP, STRAINS A,B AND C.
1     READ(5,140,END=999) TIME,(T(K),K=1,J),((S(K,L),L=1,3),K=1,J)
140   FORMAT(F8.0,12F6.2)
      IF(TIME.GT.0.)GO TO 3
      DO 6 II=1,J
      ETHC(II)=A(1)*T(II)+A(2)*T(II)**2/2.+A(3)*T(II)**3/3.+A(4)*T(II)
     1**4/4.
      DO 7 KK=1,3
7     SZERO(II,KK)=S(II,KK)
6     CONTINUE
```

```
 3    DO 8 JJ=1,J
C     TEMPERATURE COMPENSATION FOR FAER-18RB-12S13-ET LOT NO. A283
C     GAGES ON 2024-T4 ALUMINUM TEST PLATE.
      ASTR=-60.68+2.22*T(JJ)-2.40E-2*T(JJ)**2+7.05E-5*T(JJ)**3
     1-5.59E-8*T(JJ)**4
      ASTR1=-19.4979+.2463*T(JJ)+.9561E-4*T(JJ)**2-.7879E-7*T(JJ)**3
     1+.5303E-10*T(JJ)**4
      ASTR=ASTR+ASTR1
      IF(TIME.EQ.0.) GO TO 11
      DO 9 KK=1,3
 9    STRN(JJ,KK)=  S(JJ,KK)-SZERO(JJ,KK)-ASTR
      GO TO 13
 11   DO 12 KK=1,3
 12   STRN(JJ,KK)=S(JJ,KK)-ASTR
 13   CONTINUE
C     STRAINS ARE NOW TEMPERATURE COMPENSATED.
      CALL STRAIN(STRN(JJ,1),STRN(JJ,2),STRN(JJ,3),EX(JJ),EY(JJ),GXY(JJ)
     2,E1(JJ),E2(JJ),PHIX(JJ))
      CALL STRESS(EX(JJ),EY(JJ),GXY(JJ),ETHO(JJ),A,E,Y,T(JJ),NL,
     1SIGX(JJ),SIGY(JJ),TAUXY(JJ),X4(JJ),Y1(JJ),X5(JJ))
 8    CONTINUE
      WRITE(6,160)TIME,(T(K),K=1,J),((S(K,L),K=1,J),L=1,3),((STRN(K,L),K
     2=1,J),L=1,3),(EX(K),K=1,J),(EY(K),K=1,J),(GXY(K),K=1,J),(E1(K),K=1
     3,J),(E2(K),K=1,J),(PHIX(K),K=1,J)
 160  FORMAT(6X,F8.2/5X,'TEMPERATURE(DEG.FAHR)',3(F10.2,6X)/
     25X,'STRAIN A. (MEAS)',5X,3(F10.2,6X)/
     35X,'STRAIN B. (MEAS)',5X,3(F10.2,6X)/
     45X,'STRAIN C. (MEAS)',5X,3(F10.2,6X)/
     55X,'STRAIN A. (MECH)',5X,3(F10.2,6X)/
     65X,'STRAIN B. (MECH)',5X,3(F10.2,6X)/
     75X,'STRAIN C. (MECH)',5X,3(F10.2,6X)/
     85X,'STRAIN X. (MECH)',5X,3(F10.2,6X)/
     95X,'STRAIN Y. (MECH)',5X,3(F10.2,6X)/
     15X,'GAMMA XY. (MECH)',5X,3(F10.2,6X)/
     25X,'PRIN.STR.1. (" )',5X,3(F10.2,6X)/
     35X,'PRIN.STR.2. (" )',5X,3(F10.2,6X)/
```

```
     45X,'PHI X (DEGREES)',6X,3(F10.2,6X))
      WRITE(6,161) (SIGX(K),K=1,J),(SIGY(K),K=1,J),(TAUXY(K),K=1,J),
     1(Y1(K),K=1,J),(X4(K),K=1,J),(X5(K),K=1,J)
  161 FORMAT(5X,'SIGMA XX (KSI)',7X,3(F10.2,6X)/
     15X,'SIGMA YY (KSI)',7X,3(F10.2,6X)/
     25X,'TAU XY    (KSI)',7X,3(F10.2,6X)/
     35X,'YIELD STRESS (KSI)',3X,3(F10.2,6X)/
     45X,'I (KSI)',14X,3(E10.4,6X)/
     55X,'I/YIELD STRESS',7X,3(E10.4,6X)///)
      GO TO 1
  999 CALL EXIT
      END
      SUBROUTINE STRAIN(EA,EB,EC,EX,EY,GXY,E1,E2,PHIX)
C     THIS SUBROUTINE CALCULATES STRAINS ALONG THE X, Y AND PRINCIPAL
C     AXES: THE SHEAR ANGLE GAMMA XY; AND PHIX, THE ANGLE BETWEEN THE
C     X AXIS AND THE AXIS OF THE LARGEST PRINCIPAL STRAIN.
C     CALCULATIONS ARE BASED ON THE RECTANGULAR ROSETTE WITH THREE
C     OBSERVATIONS OF STRAIN.
C     PHI1 IS DEFINED AS THE ANGLE MEASURED POSITIVE IN THE ANTI-
C     CLOCKWISE DIRECTION FROM THE POSITIVE OA AXIS OF THE STRAIN
C     ROSETTE TO THE POSITIVE O1 AXIS WHICH CORRESPONDS TO THE DIRECTION
C     OF THE LARGEST PRINCIPAL STRAIN.
C     COMPUTATIONS, OTHER THAN PHI, UTILIZE AXIS OX AS THE REFERENCE
C     AXIS.
C     THE ANGLE BETWEEN THE X AXIS AND THE OA AXIS = 45 DEGREES.
      EX=EA-EB+EC
      EY=EB
      GXY=EA-EC
      A=EX+EY
      B=EX-EY
      C=SQRT(B**2+GXY**2)
      E1=.5*(A+C)
      E2=.5*(A-C)
      B1=EA-EC
      B2=EA+EC
      B3=2.*EB-B2
```

```
      IF(B1.EQ.0.)GO TO 6
      PHI1=ABS(.5*ATAN(B3/B1))
      GO TO 7
 6    PHI1=3.1416/4.
 7    CONTINUE
      D=.5*(EA+EC)
      IF(EB.GT.D)GO TO 1
      IF(EB.LT.D)GO TO 2
      IF(EA.GT.EC)GO TO 3
      IF(EA.LT.EC)GO TO 4
 1    PHI2=+PHI1
      GO TO 5
 2    PHI2=-PHI1
      GO TO 5
 3    PHI2=0.0
      GO TO 5
 4    PHI2=+3.1416/2.
 5    PHI3=PHI2*180./3.1416
      PHIX=PHI3+45.0
C     45 DEGREE CORRECTION IS MADE TO BRING THE REFERENCE AXIS
C     FROM CA TO X.
      RETURN
      END
      SUBROUTINE STRESS (EX,EY,GXY,ETHO,A,E,Y,T,NU,SIGX,SIGY,TAUXY,
     1X4,Y1,X5)
      REAL NU
      DIMENSION A(4),E(4),Y(4)
C     AT THIS POINT, THERMAL STRAINS ARE CALCULATED ASSUMING ISOTROPIC
C     MATERIAL.
      ETHT=A(1)*T+A(2)*T**2/2.+A(3)*T**3/3.+A(4)*T**4/4.
      ETH=ETHT-ETHO
C     AT THIS POINT, TOTAL STRAINS ARE CALCULATED.
      EXT=EX+ETH
      EYT=EY+ETH
      E1=E(1)+E(2)*T+E(3)*T**2+E(4)*T**3
C     E1 IS YOUNG'S MODULUS AT TEMPERATURE T.
```

Intentionally Left Blank

```
      X1=1.0E-3*E1/(1.-NU**2)
      X2=1.0E-3*E1/(2*(1.+NU))
      SIGX=X1*(EXT+NU*EYT)
      SIGY=X1*(EYT+NU*EXT)
      TAUXY=X2*GXY
C     UNITS OF STRESS ARE NOW IN KSI.   YOUNG'S MODULUS WAS READ IN
C     AS PSI * E-6 AND STRAINS WERE IN TERMS OF MICRO STRAIN.  X1 AND
C     X2 HAVE BEEN CORRECTED BY E-3 TO CONVERT PSI TO KSI.
      X3=(SIGX**2-SIGX*SIGY+SIGY**2+3.*TAUXY)
      X31=ABS(X3)
      X4=SQRT(X31)
C     K4 IS MASUBUCHI'S STRESS INVARIANT IN UNITS OF KSI.
      Y1=Y(1)+Y(2)*T+Y(3)*T**2+Y(4)*T**3
C     Y1 IS YIELD STRESS AT TEMPERATURE T IN UNITS OF KSI.
      X5=X4/Y1
C     X5 IS THE PLASTICITY CONDITION RATIO BASED ON MASUBUCHI'S STRESS
C     INVARIANT.  WHEN IT IS E.T. OR G.T. 1.0 PLASTIC STRAINING HAS
C     OCCURRED.
      RETURN
      END
```

```
$ENTRY
   3 19.0  240.0
  0.1219000E 02  0.9464994E-02 -0.1169993E-04  0.1049983E-07
  0.1020000E 02 -0.1817137E-02 -0.4810746E-05 -0.2084789E-08
  0.4050000E 02 -0.7480200E-02  0.2589436E-04 -0.1698679E-06
.333
```

0.	78.	78.	78.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10.	78.	79.	78.	15.	40.	-20.	5.	20.	-5.	10.	15.	15.
15.	79.	79.	78.	25.	115.	-75.	5.	45.	-45.	10.	20.	20.
20.	79.	79.	78.	80.	220.	-200.	35.	135.	-165.	20.	30.	20.
22.	79.	79.		150.	285.	-335.	95.	185.	-290.			
23.	79.	79.		215.	300.	-465.	155.	210.	-415.			
24.	80.	79.		315.	300.	-645.	275.	220.	-585.			
25.	82.	81.		435.	200.	-650.	465.	145.	-830.			
26.	98.	88.		250.	-100.	-950.	560.	-90.	-840.			
27.	159.	114.		-790.	-25.	-310.	-105.	85.	75.			
28.	239.	179.		-2095.	745.	-10.	80.	975.	590.			
29.	290.	234.		-1290.	1060.	-55.	375.	835.	285.			
30.	316.	269.	78.	-1050.	1575.	-255.	-55.	385.	5.	50.	95.	40.
31.	326.	288.		-470.	1550.	-325.	-320.	265.	-135.			
32.	328.	302.		-110.	1480.	-400.	-440.	195.	-205.			
34.	327.	308.	78.	-165.	1315.	-500.	-430.	90.	-295.	75.	130.	50.
40.	297.	298.	78.	-65.	865.	-565.	-355.	-80.	-385.	150.	250.	75.
45.	277.	278.	79.	-80.	645.	-530.	-335.	-160.	-390.	310.	420.	80.
49.			80.							625.	640.	-75.
50.	260.	259.	80.	-130.	460.	-490.	-330.	-215.	-385.	820.	680.	-220.
51.			82.							1090.	680.	-505.
52.			88.							1365.	470.	-875.
53.			106.							880.	145.	-645.
54.			148.							235.	310.	-30.
55.			186.							50.	540.	275.
56.			212.							-135.	640.	345.
57.			230.							270.	610.	185.
58.			244.							-155.	-110.	-5.
59.			253.							-365.	-110.	-135.
60.	227.	234.	260.	-200.	175.	-415.	-310.	-275.	-365.	-365.	-140.	-170.

```
65.      228.  224.  272.  -255. 75.   -380. -300. -320. -345. -470. -220. -135.
70.      219.  215.  263.  -245. -10.  -295. -240. -340. -335. -535. -165. -35.
100.     186.  181.  206.  -280. -265. -205. -200. -380. -255. -540. -290. -55.
200.     138.  137.  139.  -120. -285. -45.  -85.  -410. -155. -485. -365. -130.
300.     120.  121.  119.  -80.  -275. -10.  -50.  -420. -140. -475. -390. -170.
600.     99.   99.   99.   -50.  -265. 5.    -35.  -435. -135. -470. -410. -215.
900.     92.   92.   90.   -40.  -260. 10.   -25.  -435. -125. -475. -415. -225.
1200.    88.   88.   87.   -40.  -265. 5.    -80.  -425. -130. -480. -420. -240.
$STOP
/*
```

WELDING STRAIN ROSETTE DATA: EXPERIMENTAL RESULTS

TEST NUMBER 3: BEAD-ON-PLATE

ALUMINUM ALLOY 6061 IN T651 CONDITION
THICKNESS = 0.250 INCHES
GMA WELD PROCESS
ARC VOLTAGE = 19.
AMPERES = 240.
SPEED OF TRAVEL = 32.16 INCHES/MINUTE
4043 FILLER METAL: 0.0625 INCH DIAMETER
UNITS OF STRAIN = MICROSTRAIN

CAUTION

TEMP = 0.00 COMPUTATIONS REPRESENT
BLANK SPACES ON INPUT CARDS AND ARE
MEANINGLESS. IGNORE ALL SUCH COMPUTATIONS.

TIME (SECONDS)	1.00 (CENTERLINE)	3.00 (CENTERLINE)	1.00 (EDGE)
	TRANSVERSE DISTANCE FROM WELD IN INCHES		
0.00			
TEMPERATURE(DEG.FAHR)	78.00	78.00	78.00
STRAIN A. (MEAS)	0.00	0.00	0.00
STRAIN B. (MEAS)	0.00	0.00	0.00
STRAIN C. (MEAS)	0.00	0.00	0.00
STRAIN A. (MECH)	1.89	1.89	1.89
STRAIN B. (MECH)	1.89	1.89	1.89
STRAIN C. (MECH)	1.89	1.89	1.89
STRAIN X. (MECH)	1.89	1.89	1.89
STRAIN Y. (MECH)	1.89	1.89	1.89
GAMMA XY. (MECH)	0.00	0.00	0.00
PRIN.STR.1. (")	1.89	1.89	1.89
PRIN.STR.2. (")	1.89	1.89	1.89
PHI X (DEGREES)	90.00	90.00	90.00
SIGMA XX (KSI)	0.03	0.03	0.03
SIGMA YY (KSI)	0.03	0.03	0.03
TAU XY (KSI)	0.00	0.00	0.00
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.2841E-01	0.2841E-01	0.2841E-01
I/YIELD STRESS	0.7103E-03	0.7103E-03	0.7103E-03

WELDING STRAIN ROSETTE DATA: EXPERIMENTAL RESULTS

TEST NUMBER 4: BEAD-ON-PLATE

ALUMINUM ALLOY 6061 IN T651 CONDITION
THICKNESS = 0.250 INCHES
GMA WELD PROCESS
ARC VOLTAGE = 19.
AMPERES = 240.
SPEED OF TRAVEL = 32.16 INCHES/MINUTE
4043 FILLER METAL: 0.0625 INCH DIAMETER
UNITS OF STRAIN = MICROSTRAIN

CAUTION

TEMP = 0.00 COMPUTATIONS REPRESENT
BLANK SPACES ON INPUT CARDS AND ARE
MEANINGLESS. IGNORE ALL SUCH COMPUTATIONS.

TIME (SECONDS)	1.00 (CENTERLINE)	1.00 (BOTTOM C/L)	1.00 (EDGE)
	TRANSVERSE DISTANCE FROM WELD IN INCHES		
0.00			
TEMPERATURE(DEG.FAHR)	78.00	78.00	78.00
STRAIN A. (MEAS)	0.00	0.00	0.00
STRAIN B. (MEAS)	0.00	0.00	0.00
STRAIN C. (MEAS)	0.00	0.00	0.00
STRAIN A. (MECH)	1.89	1.89	1.89
STRAIN B. (MECH)	1.89	1.89	1.89
STRAIN C. (MECH)	1.89	1.89	1.89
STRAIN X. (MECH)	1.89	1.89	1.89
STRAIN Y. (MECH)	1.89	1.89	1.89
GAMMA XY. (MECH)	0.00	0.00	0.00
PRIN.STR.1. (")	1.89	1.89	1.89
PRIN.STR.2. (")	1.89	1.89	1.89
PHI X (DEGREES)	90.00	90.00	90.00
SIGMA XX (KSI)	0.03	0.03	0.03
SIGMA YY (KSI)	0.03	0.03	0.03
TAU XY (KSI)	0.00	0.00	0.00
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.2841E-01	0.2841E-01	0.2841E-01
I/YIELD STRESS	0.7103E-03	0.7103E-03	0.7103E-03

10.00

TEMPERATURE(DEG.FAHR)	79.00	77.00	78.00
STRAIN A. (MEAS)	15.00	30.00	0.00
STRAIN B. (MEAS)	30.00	20.00	0.00
STRAIN C. (MEAS)	-15.00	-30.00	0.00
STRAIN A. (MECH)	16.89	31.89	1.89
STRAIN B. (MECH)	31.89	21.89	1.99
STRAIN C. (MECH)	-13.11	-28.11	1.99
STRAIN X. (MECH)	-28.11	-19.10	1.89
STRAIN Y. (MECH)	31.89	21.92	1.99
GAMMA XY. (MECH)	30.00	60.00	0.00
PRIN.STR.1. (")	35.43	37.87	1.89
PRIN.STR.2. (")	-31.65	-34.24	1.89
PHI X (DEGREES)	76.72	61.94	90.00
SIGMA XX (KSI)	-0.21	-0.32	0.07
SIGMA YY (KSI)	0.25	-0.07	0.03
TAU XY (KSI)	0.11	0.23	0.00
YIELD STRESS (KSI)	39.99	40.00	39.99
I (KSI)	0.7015E 00	0.8791E 00	0.2841E-01
I/YIELD STRESS	0.1754E-01	0.2198E-01	0.7103E-03

15.00

TEMPERATURE(DEG.FAHR)	79.00	78.00	78.00
STRAIN A. (MEAS)	30.00	40.00	0.00
STRAIN B. (MEAS)	90.00	40.00	15.00
STRAIN C. (MEAS)	30.00	-100.00	15.00
STRAIN A. (MECH)	31.89	41.89	1.89
STRAIN B. (MECH)	91.89	41.89	16.89
STRAIN C. (MECH)	31.89	-98.11	16.89
STRAIN X. (MECH)	-28.11	-98.11	1.89
STRAIN Y. (MECH)	91.89	41.89	16.89
GAMMA XY. (MECH)	0.00	140.00	-15.00
PRIN.STR.1. (")	91.89	70.89	20.00
PRIN.STR.2. (")	-28.11	-127.11	-1.22
PHI X (DEGREES)	90.00	67.50	67.50
SIGMA XX (KSI)	0.03	-0.95	0.03
SIGMA YY (KSI)	0.93	0.10	0.20
TAU XY (KSI)	0.00	0.53	-0.04
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.9171E 00	0.1609E 01	0.3779E 00
I/YIELD STRESS	0.2293E-01	0.4024E-01	0.9349E-02

20.00

TEMPERATURE(DEG.FAHR)	78.00	78.00	78.00
STRAIN A. (MEAS)	120.00	210.00	-135.00
STRAIN B. (MEAS)	210.00	-30.00	30.00
STRAIN C. (MEAS)	-360.00	-220.00	15.00
STRAIN A. (MECH)	121.89	211.89	-133.11
STRAIN B. (MECH)	211.89	-28.11	31.89
STRAIN C. (MECH)	-358.11	-218.11	16.89
STRAIN X. (MECH)	-463.11	91.89	-149.11

10.00

TEMPERATURE(DEG.FAHR)	78.00	79.00	78.00
STRAIN A. (MEAS)	15.00	5.00	10.00
STRAIN B. (MEAS)	40.00	20.00	15.00
STRAIN C. (MEAS)	-20.00	-5.00	15.00
STRAIN A. (MECH)	16.89	6.99	11.89
STRAIN B. (MECH)	41.89	21.99	16.89
STRAIN C. (MECH)	-19.11	-3.02	16.89
STRAIN X. (MECH)	-43.11	-18.02	11.89
STRAIN Y. (MECH)	41.89	21.98	16.99
GAMMA XY. (MECH)	35.00	10.00	-5.00
PRIN.STR.1. (")	45.35	22.60	17.92
PRIN.STR.2. (")	-46.57	-18.63	10.85
PHI X (DEGREES)	73.81	82.98	67.50
SIGMA XX (KSI)	-0.33	0.07	0.20
SIGMA YY (KSI)	0.31	0.37	0.24
TAU XY (KSI)	0.13	0.04	-0.02
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.8377E 00	0.4901E 00	0.9251E-01
I/YIELD STRESS	0.2095E-01	0.1201E-01	0.2313E-02

15.00

TEMPERATURE(DEG.FAHR)	79.00	79.00	79.00
STRAIN A. (MEAS)	25.00	5.00	10.00
STRAIN B. (MEAS)	115.00	45.00	20.00
STRAIN C. (MEAS)	-75.00	-45.00	20.00
STRAIN A. (MECH)	26.98	6.98	11.89
STRAIN B. (MECH)	116.98	46.98	21.89
STRAIN C. (MECH)	-73.02	-43.02	21.89
STRAIN X. (MECH)	-163.02	-83.02	11.89
STRAIN Y. (MECH)	116.98	46.98	21.89
GAMMA XY. (MECH)	100.00	50.00	-10.00
PRIN.STR.1. (")	125.64	51.62	23.96
PRIN.STR.2. (")	-171.68	-97.66	9.82
PHI X (DEGREES)	90.17	79.48	67.50
SIGMA XX (KSI)	-1.21	-0.57	0.22
SIGMA YY (KSI)	0.99	0.41	0.29
TAU XY (KSI)	0.38	0.19	-0.04
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.2116E 01	0.1134E 01	0.2101E 00
I/YIELD STRESS	0.5292E-01	0.2837E-01	0.5252E-02

20.00

TEMPERATURE(DEG.FAHR)	79.00	79.00	78.00
STRAIN A. (MEAS)	80.00	35.00	20.00
STRAIN B. (MEAS)	220.00	135.00	30.00
STRAIN C. (MEAS)	-200.00	-165.00	20.00
STRAIN A. (MECH)	81.93	36.98	21.89
STRAIN B. (MECH)	221.93	136.98	31.89
STRAIN C. (MECH)	-198.02	-163.02	21.89
STRAIN X. (MECH)	-329.02	-263.02	11.89

STRAIN Y. (MECH)	211.89	-88.11	31.89
GAMMA XY. (MECH)	480.00	430.00	-150.00
PRIN.STR.1. (")	289.93	228.08	59.04
PRIN.STR.2. (")	-526.15	-234.30	-175.26
PHI X (DEGREES)	71.99	34.21	70.10
SIGMA XX (KSI)	-4.26	0.59	-1.55
SIGMA YY (KSI)	0.71	-0.69	-0.20
TAU XY (KSI)	1.81	1.62	-0.56
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.5202E 01	0.2466E 01	0.6677E 00
I/YIELD STRESS	0.1301E 00	0.6166E-01	0.1670E-01

21.00

TEMPERATURE(DEG.FAHR)	78.00	78.00
STRAIN A. (MEAS)	150.00	230.00
STRAIN B. (MEAS)	210.00	-10.00
STRAIN C. (MEAS)	-270.00	-260.00
STRAIN A. (MECH)	151.89	231.89
STRAIN B. (MECH)	211.89	-8.11
STRAIN C. (MECH)	-268.11	-258.11
STRAIN X. (MECH)	-328.11	-18.11
STRAIN Y. (MECH)	211.89	-8.11
GAMMA XY. (MECH)	420.00	490.00
PRIN.STR.1. (")	283.94	231.94
PRIN.STR.2. (")	-400.15	-258.16
PHI X (DEGREES)	71.06	45.58
SIGMA XX (KSI)	-2.90	-0.23
SIGMA YY (KSI)	1.16	-0.16
TAU XY (KSI)	1.58	1.84
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.4228E 01	0.2361E 01
I/YIELD STRESS	0.1057E 00	0.5902E-01

22.00

TEMPERATURE(DEG.FAHR)	78.00	78.00
STRAIN A. (MEAS)	180.00	250.00
STRAIN B. (MEAS)	240.00	-50.00
STRAIN C. (MEAS)	-375.00	-270.00
STRAIN A. (MECH)	181.89	251.89
STRAIN B. (MECH)	241.89	-48.11
STRAIN C. (MECH)	-373.11	-268.11
STRAIN X. (MECH)	-433.11	31.89
STRAIN Y. (MECH)	241.89	-48.11
GAMMA XY. (MECH)	555.00	520.00
PRIN.STR.1. (")	341.32	254.05
PRIN.STR.2. (")	-532.55	-271.17
PHI X (DEGREES)	70.29	40.63
SIGMA XX (KSI)	-3.98	0.13
SIGMA YY (KSI)	1.10	-0.42
TAU XY (KSI)	2.09	1.76
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.5262E 01	0.2491E 01

STRAIN Y. (MECH)	221.98	136.98	31.89
GAMMA XY. (MECH)	280.00	200.00	0.00
PRIN.STR.1. (")	255.03	160.59	31.89
PRIN.STR.2. (")	-371.07	-286.62	11.89
PHI X (DEGREES)	76.72	76.72	90.00
SIGMA XX (KSI)	-2.78	-2.26	0.25
SIGMA YY (KSI)	1.43	0.75	0.40
TAU XY (KSI)	1.05	0.75	0.00
YIELD STRESS (KSI)	39.99	39.99	39.99
I (KSI)	0.4114E 01	0.3100E 01	0.3540E 00
I/YIELD STRESS	0.1029E 00	0.7753E-01	0.8850E-02

22.00

TEMPERATURE(DEG.FAHR)	79.00	79.00
STRAIN A. (MEAS)	150.00	95.00
STRAIN B. (MEAS)	285.00	185.00
STRAIN C. (MEAS)	-335.00	-290.00
STRAIN A. (MECH)	151.98	96.98
STRAIN B. (MECH)	286.98	186.98
STRAIN C. (MECH)	-333.02	-288.02
STRAIN X. (MECH)	-468.02	-378.02
STRAIN Y. (MECH)	286.98	186.98
GAMMA XY. (MECH)	485.00	395.00
PRIN.STR.1. (")	352.15	246.33
PRIN.STR.2. (")	-539.20	-437.37
PHI X (DEGREES)	73.64	72.96
SIGMA XX (KSI)	-4.01	-3.37
SIGMA YY (KSI)	1.67	0.98
TAU XY (KSI)	1.82	1.45
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.5562E 01	0.4409E 01
I/YIELD STRESS	0.1393E 00	0.1102E 00

23.00

TEMPERATURE(DEG.FAHR)	79.00	79.00
STRAIN A. (MEAS)	215.00	155.00
STRAIN B. (MEAS)	300.00	210.00
STRAIN C. (MEAS)	-465.00	-415.00
STRAIN A. (MECH)	216.98	156.98
STRAIN B. (MECH)	301.98	211.98
STRAIN C. (MECH)	-463.02	-413.02
STRAIN X. (MECH)	-543.02	-468.02
STRAIN Y. (MECH)	301.98	211.98
GAMMA XY. (MECH)	630.00	570.00
PRIN.STR.1. (")	421.25	315.63
PRIN.STR.2. (")	-667.28	-571.67
PHI X (DEGREES)	70.67	70.91
SIGMA XX (KSI)	-4.85	-4.29
SIGMA YY (KSI)	1.54	0.83
TAU XY (KSI)	2.56	2.14
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.6408E 01	0.5389E 01

1/YIELD STRESS	0.1315E 00	0.6203E-01

23.00

TEMPERATURE(DEG.FAHR)	79.00	78.00
STRAIN A. (MEAS)	270.00	280.00
STRAIN B. (MEAS)	240.00	-90.00
STRAIN C. (MEAS)	-480.00	-290.00
STRAIN A. (MECH)	271.98	281.99
STRAIN B. (MECH)	241.98	-88.11
STRAIN C. (MECH)	-478.02	-288.11
STRAIN X. (MECH)	-448.02	91.89
STRAIN Y. (MECH)	241.98	-88.11
GAMMA XY. (MECH)	750.00	570.00
PRIN.STR.1. (")	406.54	294.30
PRIN.STR.2. (")	-612.58	-300.52
PHI X (DEGREES)	56.31	36.70
SIGMA XX (KSI)	-3.95	0.59
SIGMA YY (KSI)	1.24	-0.62
TAU XY (KSI)	2.82	2.14
YIELD STRESS (KSI)	39.99	39.99
T (KSI)	0.5522E 01	0.2749E 01
1/YIELD STRESS	0.1381E 00	0.6921E-01

24.00

TEMPERATURE(DEG.FAHR)	79.00	79.00
STRAIN A. (MEAS)	345.00	290.00
STRAIN B. (MEAS)	210.00	-120.00
STRAIN C. (MEAS)	-630.00	-260.00
STRAIN A. (MECH)	346.98	291.99
STRAIN B. (MECH)	211.98	-118.11
STRAIN C. (MECH)	-628.02	-258.11
STRAIN X. (MECH)	-493.02	151.89
STRAIN Y. (MECH)	211.98	-118.11
GAMMA XY. (MECH)	975.00	550.00
PRIN.STR.1. (")	461.07	323.24
PRIN.STR.2. (")	-742.11	-289.46
PHI X (DEGREES)	62.93	31.93
SIGMA XX (KSI)	-4.57	1.27
SIGMA YY (KSI)	0.73	-0.76
TAU XY (KSI)	3.67	2.07
YIELD STRESS (KSI)	39.99	39.99
T (KSI)	0.5983E 01	0.3060E 01
1/YIELD STRESS	0.1496E 00	0.7652E-01

25.00

TEMPERATURE(DEG.FAHR)	80.00	79.00
STRAIN A. (MEAS)	465.00	290.00
STRAIN B. (MEAS)	30.00	-130.00
STRAIN C. (MEAS)	-925.00	-230.00
STRAIN A. (MECH)	467.00	291.98

1/YIELD STRESS	0.1603E 00	0.1348E 00

24.00

TEMPERATURE(DEG.FAHR)	80.00	79.00
STRAIN A. (MEAS)	315.00	275.00
STRAIN B. (MEAS)	300.00	220.00
STRAIN C. (MEAS)	-645.00	-585.00
STRAIN A. (MECH)	317.09	276.98
STRAIN B. (MECH)	302.09	221.98
STRAIN C. (MECH)	-642.91	-583.02
STRAIN X. (MECH)	-627.91	-528.02
STRAIN Y. (MECH)	302.09	221.98
GAMMA XY. (MECH)	960.00	860.00
PRIN.STR.1. (")	595.39	417.53
PRIN.STR.2. (")	-831.21	-723.57
PHI X (DEGREES)	67.05	65.55
SIGMA XX (KSI)	-5.56	-4.93
SIGMA YY (KSI)	1.44	0.71
TAU XY (KSI)	3.61	3.23
YIELD STRESS (KSI)	39.98	39.99
T (KSI)	0.7194E 01	0.6165E 01
1/YIELD STRESS	0.1799E 00	0.1542E 00

25.00

TEMPERATURE(DEG.FAHR)	82.00	81.00
STRAIN A. (MEAS)	435.00	465.00
STRAIN B. (MEAS)	200.00	145.00
STRAIN C. (MEAS)	-650.00	-930.00
STRAIN A. (MECH)	437.37	467.22
STRAIN B. (MECH)	202.37	147.22
STRAIN C. (MECH)	-647.63	-927.78
STRAIN X. (MECH)	-412.63	-507.78
STRAIN Y. (MECH)	202.37	147.22
GAMMA XY. (MECH)	1085.00	1295.00
PRIN.STR.1. (")	513.46	545.33
PRIN.STR.2. (")	-728.72	-905.89
PHI X (DEGREES)	59.77	59.41
SIGMA XX (KSI)	-3.12	-4.59
SIGMA YY (KSI)	1.51	0.33
TAU XY (KSI)	4.08	4.87
YIELD STRESS (KSI)	39.97	39.97
T (KSI)	0.5276E 01	0.6108E 01
1/YIELD STRESS	0.1345E 00	0.1528E 00

26.00

TEMPERATURE(DEG.FAHR)	98.00	89.00
STRAIN A. (MEAS)	250.00	560.00
STRAIN B. (MEAS)	-100.00	-90.00
STRAIN C. (MEAS)	-950.00	-840.00
STRAIN A. (MECH)	256.93	563.62

STRAIN B. (MECH)	92.09	-128.02
STRAIN C. (MECH)	-822.91	-228.02
STRAIN X. (MECH)	-447.91	191.98
STRAIN Y. (MECH)	92.09	-128.02
GAMMA XY. (MECH)	1290.00	520.00
PRIN.STR.1. (")	521.33	337.27
PRIN.STR.2. (")	-877.14	-273.30
PHI X (DEGREES)	56.36	29.20
SIGMA XX (KSI)	-4.32	1.98
SIGMA YY (KSI)	-0.26	-0.53
TAU XY (KSI)	4.85	1.96
YIELD STRESS (KSI)	39.98	39.99
T (KSI)	0.5669E 01	0.3266E 01
T/YIELD STRESS	0.1418E 00	0.8167E-01

26.00

TEMPERATURE(DEG.FAHR)	89.00	78.00
STRAIN A. (MEAS)	360.00	290.00
STRAIN B. (MEAS)	-180.00	-130.00
STRAIN C. (MEAS)	-840.00	-170.00
STRAIN A. (MECH)	363.88	291.39
STRAIN B. (MECH)	-176.12	-128.11
STRAIN C. (MECH)	-836.12	-168.11
STRAIN X. (MECH)	-296.12	251.89
STRAIN Y. (MECH)	-176.12	-128.11
GAMMA XY. (MECH)	1200.00	460.00
PRIN.STR.1. (")	366.88	360.22
PRIN.STR.2. (")	-839.11	-236.44
PHI X (DEGREES)	47.85	25.22
SIGMA XX (KSI)	-1.86	2.36
SIGMA YY (KSI)	-0.96	-0.59
TAU XY (KSI)	4.50	1.73
YIELD STRESS (KSI)	39.93	39.99
T (KSI)	0.4013E 01	0.3451E 01
T/YIELD STRESS	0.1005E 00	0.8728E-01

27.00

TEMPERATURE(DEG.FAHR)	130.00	78.00
STRAIN A. (MEAS)	-420.00	300.00
STRAIN B. (MEAS)	-300.00	-90.00
STRAIN C. (MEAS)	-210.00	-100.00
STRAIN A. (MECH)	-395.22	301.89
STRAIN B. (MECH)	-275.22	-88.11
STRAIN C. (MECH)	-185.22	-98.11
STRAIN X. (MECH)	-305.22	291.89
STRAIN Y. (MECH)	-275.22	-89.11
GAMMA XY. (MECH)	-210.00	400.00
PRIN.STR.1. (")	-184.16	377.75
PRIN.STR.2. (")	-396.29	-173.97
PHI X (DEGREES)	49.07	23.23
SIGMA XX (KSI)	5.65	2.96
SIGMA YY (KSI)	5.87	0.19

STRAIN B. (MECH)	-93.07	-86.39
STRAIN C. (MECH)	-943.07	-836.39
STRAIN X. (MECH)	-593.07	-186.39
STRAIN Y. (MECH)	-93.07	-86.39
GAMMA XY. (MECH)	1200.00	1400.00
PRIN.STR.1. (")	304.03	565.40
PRIN.STR.2. (")	-993.07	-839.17
PHI X (DEGREES)	56.31	47.04
SIGMA XX (KSI)	-3.12	-3.49
SIGMA YY (KSI)	0.61	0.26
TAU XY (KSI)	4.49	5.25
YIELD STRESS (KSI)	39.86	39.93
T (KSI)	0.5055E 01	0.4024E 01
T/YIELD STRESS	0.1268E 00	0.1008E 00

27.00

TEMPERATURE(DEG.FAHR)	150.00	114.00
STRAIN A. (MEAS)	-790.00	-105.00
STRAIN B. (MEAS)	-25.00	85.00
STRAIN C. (MEAS)	-310.00	75.00
STRAIN A. (MECH)	-745.01	-90.22
STRAIN B. (MECH)	19.99	99.78
STRAIN C. (MECH)	-265.01	89.78
STRAIN X. (MECH)	-1030.01	-100.22
STRAIN Y. (MECH)	19.99	99.78
GAMMA XY. (MECH)	-490.00	-180.00
PRIN.STR.1. (")	72.24	134.32
PRIN.STR.2. (")	-1082.27	-134.75
PHI X (DEGREES)	77.72	69.01
SIGMA XX (KSI)	4.37	6.22
SIGMA YY (KSI)	12.09	7.71
TAU XY (KSI)	-1.76	-0.67
YIELD STRESS (KSI)	39.29	39.73
T (KSI)	0.1034E 02	0.6937E 01
T/YIELD STRESS	0.2632E 00	0.1746E 00

28.00

TEMPERATURE(DEG.FAHR)	239.00	179.00
STRAIN A. (MEAS)	-2995.00	80.00
STRAIN B. (MEAS)	745.00	875.00
STRAIN C. (MEAS)	-10.00	590.00
STRAIN A. (MECH)	-2017.99	138.08
STRAIN B. (MECH)	822.01	933.09
STRAIN C. (MECH)	67.01	648.09
STRAIN X. (MECH)	-2772.99	-146.92
STRAIN Y. (MECH)	822.01	933.08
GAMMA XY. (MECH)	-2085.00	-510.00
PRIN.STR.1. (")	1102.44	990.26
PRIN.STR.2. (")	-3053.42	-204.10
PHI X (DEGREES)	74.94	77.36
SIGMA XX (KSI)	4.06	21.24
SIGMA YY (KSI)	29.58	29.10

TAU XY (KSI)	-0.78	1.50
YIELD STRESS (KSI)	39.50	39.00
I (KSI)	0.5555E 01	0.3606E 01
I/YIELD STRESS	0.1403E 00	0.9012E-01

28.00

TEMPERATURE(DEG.FAHR)	191.00	79.00
STRAIN A. (MEAS)	-1065.00	320.00
STRAIN B. (MEAS)	193.00	-43.00
STRAIN C. (MEAS)	151.00	-51.10
STRAIN A. (MECH)	-1030.10	321.00
STRAIN B. (MECH)	244.81	-38.10
STRAIN C. (MECH)	214.81	-48.00
STRAIN X. (MECH)	-1033.11	311.90
STRAIN Y. (MECH)	244.81	-33.00
GAMMA XY. (MECH)	-1215.00	270.00
PRIN.STR.1. (")	487.91	301.64
PRIN.STR.2. (")	-1272.20	-117.67
PHI X (DEGREES)	63.19	23.31
SIGMA XX (KSI)	11.41	3.57
SIGMA YY (KSI)	31.65	1.04
TAU XY (KSI)	-4.40	1.30
YIELD STRESS (KSI)	38.83	33.00
I (KSI)	0.1755E 02	0.3800E 01
I/YIELD STRESS	0.4519E 00	0.9504E-01

29.00

TEMPERATURE(DEG.FAHR)	243.00	79.00
STRAIN A. (MEAS)	-1245.00	351.00
STRAIN B. (MEAS)	555.00	-10.00
STRAIN C. (MEAS)	60.00	-40.00
STRAIN A. (MECH)	-1169.34	351.98
STRAIN B. (MECH)	631.66	-3.02
STRAIN C. (MECH)	136.66	-38.02
STRAIN X. (MECH)	-1663.34	321.00
STRAIN Y. (MECH)	631.66	-8.00
GAMMA XY. (MECH)	-1335.00	300.00
PRIN.STR.1. (")	804.21	412.42
PRIN.STR.2. (")	-1835.90	-93.46
PHI X (DEGREES)	75.19	24.98
SIGMA XX (KSI)	15.96	3.71
SIGMA YY (KSI)	32.22	1.31
TAU XY (KSI)	-4.62	1.47
YIELD STRESS (KSI)	37.77	39.00
I (KSI)	0.2765E 02	0.3942E 01
I/YIELD STRESS	0.7322E 00	0.9857E-01

30.00

TEMPERATURE(DEG.FAHR)	272.00	81.00	78.00
STRAIN A. (MEAS)	-1245.00	383.00	45.00

TAU XY (KSI)	-7.40	-1.86
YIELD STRESS (KSI)	37.87	39.02
I (KSI)	0.2737E 02	0.2597E 02
I/YIELD STRESS	0.7227E 00	0.6656E 00

29.00

TEMPERATURE(DEG.FAHR)	290.00	234.00
STRAIN A. (MEAS)	-1290.00	375.00
STRAIN B. (MEAS)	1060.00	835.00
STRAIN C. (MEAS)	-55.00	285.00
STRAIN A. (MECH)	-1237.20	452.11
STRAIN B. (MECH)	1112.80	912.11
STRAIN C. (MECH)	-2.20	362.11
STRAIN X. (MECH)	-2352.20	-97.89
STRAIN Y. (MECH)	1112.80	912.11
GAMMA XY. (MECH)	-1235.00	90.00
PRIN.STR.1. (")	1219.56	914.11
PRIN.STR.2. (")	-2458.95	-99.89
PHI X (DEGREES)	80.13	87.45
SIGMA XX (KSI)	19.24	31.94
SIGMA YY (KSI)	43.20	39.13
TAU XY (KSI)	-4.27	0.32
YIELD STRESS (KSI)	36.37	37.99
I (KSI)	0.3731E 02	0.3605E 02
I/YIELD STRESS	0.1026E 01	0.9499E 00

30.00

TEMPERATURE(DEG.FAHR)	316.00	269.00	73.00
STRAIN A. (MEAS)	-1050.00	-55.00	50.00
STRAIN B. (MEAS)	1575.00	395.00	95.00
STRAIN C. (MEAS)	-255.00	5.00	40.00
STRAIN A. (MECH)	-1027.42	13.15	51.89
STRAIN B. (MECH)	1597.59	453.15	96.89
STRAIN C. (MECH)	-232.42	73.15	41.93
STRAIN X. (MECH)	-2357.42	-266.85	-2.11
STRAIN Y. (MECH)	1597.58	453.15	96.85
GAMMA XY. (MECH)	-795.00	-40.00	10.00
PRIN.STR.1. (")	1632.77	454.25	97.14
PRIN.STR.2. (")	-2892.60	-367.94	-3.36
PHI X (DEGREES)	94.94	87.21	37.14
SIGMA XX (KSI)	20.49	33.02	0.33
SIGMA YY (KSI)	50.84	39.55	1.02
TAU XY (KSI)	-2.71	-0.21	0.04
YIELD STRESS (KSI)	35.36	37.06	39.40
I (KSI)	0.4421E 02	0.3701E 02	0.1017E 01
I/YIELD STRESS	0.1250E 01	0.9983E 00	0.2543E-01

31.00

TEMPERATURE(DEG.FAHR)	326.00	238.00
STRAIN A. (MEAS)	-470.00	-320.00

STRAIN B. (MEAS)	780.00	0.00	105.00
STRAIN C. (MEAS)	-75.00	-10.00	15.00
STRAIN A. (MECH)	-1179.56	382.22	45.89
STRAIN B. (MECH)	846.44	2.22	106.99
STRAIN C. (MECH)	-8.56	-7.78	16.89
STRAIN X. (MECH)	-2033.56	372.22	-43.11
STRAIN Y. (MECH)	846.44	2.22	106.89
GAMMA XY. (MECH)	-1170.00	300.00	20.00
PRIN.STR.1. (")	960.73	456.02	128.27
PRIN.STR.2. (")	-2147.85	-81.57	-44.60
PHI X (DEGREES)	70.05	23.25	24.34
SIGMA XX (KSI)	18.23	4.70	-0.08
SIGMA YY (KSI)	38.33	2.00	1.04
TAU XY (KSI)	-4.03	1.47	0.11
YIELD STRESS (KSI)	36.96	30.07	30.03
T (KSI)	0.3307E 02	0.4659E 01	0.1234E 01
T/YIELD STRESS	0.8947E 00	0.1166E 00	0.3955E-01

31.00

TEMPERATURE(DEG.FAHR)	223.00	94.00
STRAIN A. (MEAS)	-1245.00	370.00
STRAIN B. (MEAS)	915.00	0.00
STRAIN C. (MEAS)	-210.00	10.00
STRAIN A. (MECH)	-1192.30	372.72
STRAIN B. (MECH)	963.61	2.72
STRAIN C. (MECH)	-155.39	12.72
STRAIN X. (MECH)	-2315.39	382.72
STRAIN Y. (MECH)	968.61	2.72
GAMMA XY. (MECH)	-1035.00	360.00
PRIN.STR.1. (")	1049.21	454.44
PRIN.STR.2. (")	-2374.00	-69.01
PHI X (DEGREES)	81.25	21.73
SIGMA XX (KSI)	13.75	5.48
SIGMA YY (KSI)	41.42	2.63
TAU XY (KSI)	-3.53	1.35
YIELD STRESS (KSI)	36.44	39.95
T (KSI)	0.3584E 02	0.5157E 01
T/YIELD STRESS	0.9837E 00	0.1291E 00

32.00

TEMPERATURE(DEG.FAHR)	297.00	88.00
STRAIN A. (MEAS)	-1170.00	340.00
STRAIN B. (MEAS)	945.00	-20.00
STRAIN C. (MEAS)	-330.00	30.00
STRAIN A. (MECH)	-1124.09	343.62
STRAIN B. (MECH)	990.91	-16.39
STRAIN C. (MECH)	-284.09	33.62
STRAIN X. (MECH)	-2390.03	393.62
STRAIN Y. (MECH)	990.91	-16.38
GAMMA XY. (MECH)	-940.00	310.00
PRIN.STR.1. (")	1042.17	445.62
PRIN.STR.2. (")	-2451.35	-68.38

STRAIN B. (MEAS)	1550.00	265.00
STRAIN C. (MEAS)	-325.00	-135.00
STRAIN A. (MECH)	-462.42	-265.39
STRAIN B. (MECH)	1557.58	319.61
STRAIN C. (MECH)	-317.42	-80.39
STRAIN X. (MECH)	-2337.42	-665.39
STRAIN Y. (MECH)	1557.58	319.61
GAMMA XY. (MECH)	-145.00	-195.00
PRIN.STR.1. (")	1558.93	328.22
PRIN.STR.2. (")	-2338.76	-674.00
PHI X (DEGREES)	88.93	94.69
SIGMA XX (KSI)	27.45	33.63
SIGMA YY (KSI)	53.82	40.45
TAU XY (KSI)	-0.49	-0.64
YIELD STRESS (KSI)	34.93	36.44
T (KSI)	0.4660E 02	0.3749E 02
T/YIELD STRESS	0.1334E 01	0.1029E 01

33.00

TEMPERATURE(DEG.FAHR)	322.00	302.00
STRAIN A. (MEAS)	-110.00	-440.00
STRAIN B. (MEAS)	1480.00	195.00
STRAIN C. (MEAS)	-400.00	-205.00
STRAIN A. (MECH)	-105.64	-309.58
STRAIN B. (MECH)	1494.35	235.42
STRAIN C. (MECH)	-395.64	-164.58
STRAIN X. (MECH)	-1985.64	-790.53
STRAIN Y. (MECH)	1494.36	235.42
GAMMA XY. (MECH)	290.00	-235.00
PRIN.STR.1. (")	1490.41	249.55
PRIN.STR.2. (")	-1991.69	-812.75
PHI X (DEGREES)	87.61	83.60
SIGMA XX (KSI)	31.13	34.43
SIGMA YY (KSI)	54.59	41.54
TAU XY (KSI)	0.98	-0.81
YIELD STRESS (KSI)	34.84	35.92
T (KSI)	0.4746E 02	0.3845E 02
T/YIELD STRESS	0.1362E 01	0.1070E 01

34.00

TEMPERATURE(DEG.FAHR)	327.00	309.00	78.00
STRAIN A. (MEAS)	-165.00	-430.00	75.00
STRAIN B. (MEAS)	1315.00	90.00	130.00
STRAIN C. (MEAS)	-500.00	-295.00	50.00
STRAIN A. (MECH)	-150.02	-296.77	76.39
STRAIN B. (MECH)	1329.98	123.33	131.39
STRAIN C. (MECH)	-494.02	-261.77	51.89
STRAIN X. (MECH)	-1974.02	-781.77	-3.11
STRAIN Y. (MECH)	1320.98	123.33	131.95
GAMMA XY. (MECH)	335.00	-135.30	25.00
PRIN.STR.1. (")	1329.47	128.33	132.04
PRIN.STR.2. (")	-1982.51	-786.79	-4.26

PHI X (DEGREES)	83.04	18.55
SIGMA XX (KSI)	19.63	6.30
SIGMA YY (KSI)	42.98	3.22
TAU XY (KSI)	-2.89	1.16
YIELD STRESS (KSI)	36.11	39.93
T (KSI)	0.3715E 02	0.5768E 01
T/YIELD STRESS	0.1029E 01	0.1445E 00

33.00

TEMPERATURE(DEG.FAHR)	300.00	91.00
STRAIN A. (MEAS)	-1080.00	290.00
STRAIN B. (MEAS)	975.00	-20.00
STRAIN C. (MEAS)	-450.00	60.00
STRAIN A. (MECH)	-1037.33	294.46
STRAIN B. (MECH)	1017.67	-15.54
STRAIN C. (MECH)	-407.33	64.46
STRAIN X. (MECH)	-2462.33	374.46
STRAIN Y. (MECH)	1017.67	-15.54
GAMMA XY. (MECH)	-630.00	230.00
PRIN.STR.1. (")	1045.95	405.34
PRIN.STR.2. (")	-2490.61	-46.03
PHI X (DEGREES)	94.97	15.26
SIGMA XX (KSI)	19.62	6.67
SIGMA YY (KSI)	43.55	3.74
TAU XY (KSI)	-2.17	0.86
YIELD STRESS (KSI)	36.00	39.91
T (KSI)	0.3762E 02	0.6006E 01
T/YIELD STRESS	0.1047E 01	0.1505E 00

34.00

TEMPERATURE(DEG.FAHR)	300.00	95.00
STRAIN A. (MEAS)	-1005.00	240.00
STRAIN B. (MEAS)	960.00	-20.00
STRAIN C. (MEAS)	-495.00	90.00
STRAIN A. (MECH)	-962.33	246.16
STRAIN B. (MECH)	1002.67	-13.84
STRAIN C. (MECH)	-452.33	96.16
STRAIN X. (MECH)	-2417.33	356.15
STRAIN Y. (MECH)	1002.67	-13.84
GAMMA XY. (MECH)	-510.00	150.00
PRIN.STR.1. (")	1021.58	370.73
PRIN.STR.2. (")	-2436.24	-29.47
PHI X (DEGREES)	85.76	11.03
SIGMA XX (KSI)	20.04	7.43
SIGMA YY (KSI)	43.55	4.66
TAU XY (KSI)	-1.75	0.56
YIELD STRESS (KSI)	36.00	39.87
T (KSI)	0.3769E 02	0.6630E 01
T/YIELD STRESS	0.1047E 01	0.1663E 00

PHI X (DEGREES)	87.10	85.74	64.75
SIGMA XX (KSI)	30.52	35.28	0.46
SIGMA YY (KSI)	52.81	41.49	1.49
TAU XY (KSI)	1.13	-0.46	0.09
YIELD STRESS (KSI)	34.89	35.60	39.99
T (KSI)	0.4596E 02	0.3873E 02	0.1412E 01
T/YIELD STRESS	0.1317E 01	0.1085E 01	0.3530E-01

40.00

TEMPERATURE(DEG.FAHR)	297.00	298.00	78.00
STRAIN A. (MEAS)	-65.00	-355.00	150.00
STRAIN B. (MEAS)	855.00	-80.00	250.00
STRAIN C. (MEAS)	-555.00	-285.00	75.00
STRAIN A. (MECH)	-19.09	-310.15	151.92
STRAIN B. (MECH)	910.91	-35.15	251.89
STRAIN C. (MECH)	-519.09	-240.15	76.89
STRAIN X. (MECH)	-1449.09	-615.15	-73.11
STRAIN Y. (MECH)	910.91	-35.15	251.89
GAMMA XY. (MECH)	500.00	30.00	75.00
PRIN.STR.1. (")	937.19	-34.77	256.91
PRIN.STR.2. (")	-1475.29	-615.54	-78.13
PHI X (DEGREES)	34.02	89.57	12.37
SIGMA XX (KSI)	20.16	34.70	0.60
SIGMA YY (KSI)	45.42	30.63	2.75
TAU XY (KSI)	1.72	0.11	0.23
YIELD STRESS (KSI)	36.11	36.09	39.90
T (KSI)	0.3993E 02	0.3676E 02	0.2642E 01
T/YIELD STRESS	0.1106E 01	0.1022E 01	0.6622E-01

45.00

TEMPERATURE(DEG.FAHR)	277.00	278.00	76.00
STRAIN A. (MEAS)	-90.00	-335.00	31[illegible]
STRAIN B. (MEAS)	645.00	-160.00	420.0[illegible]
STRAIN C. (MEAS)	-530.00	-290.00	[illegible]
STRAIN A. (MECH)	-16.76	-272.46	311.98
STRAIN B. (MECH)	708.24	-97.46	421.50
STRAIN C. (MECH)	-466.76	-327.46	1.9[illegible]
STRAIN X. (MECH)	-1191.76	-572.46	[illegible]
STRAIN Y. (MECH)	709.24	-97.46	421.5[illegible]
GAMMA XY. (MECH)	450.00	55.00	210.00
PRIN.STR.1. (")	734.52	-95.60	446.67
PRIN.STR.2. (")	-1219.04	-594.32	-55.7[illegible]
PHI X (DEGREES)	93.34	86.13	76.46
SIGMA XX (KSI)	27.52	32.11	1.44
SIGMA YY (KSI)	40.75	34.91	4.85
TAU XY (KSI)	1.57	0.19	0.26
YIELD STRESS (KSI)	36.80	36.77	39.9[illegible]
T (KSI)	0.3607E 02	0.3360E 02	0.4557E 01
T/YIELD STRESS	0.9801E 00	0.9139E 00	0.1150E 00

35.00

TEMPERATURE(DEG.FAHR)	300.00	100.00
STRAIN A. (MEAS)	-930.00	190.00
STRAIN B. (MEAS)	915.00	-20.00
STRAIN C. (MEAS)	-525.00	120.00
STRAIN A. (MECH)	-987.33	197.76
STRAIN B. (MECH)	957.67	-12.24
STRAIN C. (MECH)	-482.33	127.76
STRAIN X. (MECH)	-2327.33	337.76
STRAIN Y. (MECH)	957.67	-12.24
GAMMA XY. (MECH)	-405.00	70.00
PRIN.STR.1. (")	970.11	341.22
PRIN.STR.2. (")	-2339.76	-15.71
PHI X (DEGREES)	86.49	5.66
SIGMA XX (KSI)	20.81	8.00
SIGMA YY (KSI)	43.40	5.38
TAU XY (KSI)	-1.39	0.76
YIELD STRESS (KSI)	35.00	39.84
T (KSI)	0.3754E 02	0.7118E 01
T/YIELD STRESS	0.1043E 01	0.1787E 00

36.00

TEMPERATURE(DEG.FAHR)	299.00	106.00
STRAIN A. (MEAS)	-915.00	130.00
STRAIN B. (MEAS)	870.00	-10.00
STRAIN C. (MEAS)	-570.00	120.00
STRAIN A. (MECH)	-871.23	140.52
STRAIN B. (MECH)	913.77	0.52
STRAIN C. (MECH)	-526.23	130.52
STRAIN X. (MECH)	-2311.23	270.52
STRAIN Y. (MECH)	913.77	0.52
GAMMA XY. (MECH)	-345.00	10.00
PRIN.STR.1. (")	922.97	270.61
PRIN.STR.2. (")	-2320.43	0.43
PHI X (DEGREES)	86.95	1.06
SIGMA XX (KSI)	20.64	8.45
SIGMA YY (KSI)	42.83	6.43
TAU XY (KSI)	-1.19	0.04
YIELD STRESS (KSI)	36.04	39.80
T (KSI)	0.3705E 02	0.7649E 01
T/YIELD STRESS	0.1028E 01	0.1922E 00

37.00

TEMPERATURE(DEG.FAHR)	296.00	110.00
STRAIN A. (MEAS)	-840.00	80.00
STRAIN B. (MEAS)	825.00	10.00
STRAIN C. (MEAS)	-600.00	120.00
STRAIN A. (MECH)	-793.05	92.57
STRAIN B. (MECH)	871.95	22.57
STRAIN C. (MECH)	-553.05	132.57
STRAIN X. (MECH)	-2218.05	202.57
STRAIN Y. (MECH)	871.95	22.57

49.00

TEMPERATURE(DEG.FAHR)			90.00
STRAIN A. (MEAS)			625.00
STRAIN B. (MEAS)			640.00
STRAIN C. (MEAS)			-75.00
STRAIN A. (MECH)			627.09
STRAIN B. (MECH)			642.09
STRAIN C. (MECH)			-72.91
STRAIN X. (MECH)			-87.91
STRAIN Y. (MECH)			642.09
GAMMA XY. (MECH)			700.00
PRIN.STR.1. (")			782.79
PRIN.STR.2. (")			-228.62
PHI X (DEGREES)			68.10
SIGMA XX (KSI)			1.81
SIGMA YY (KSI)			7.29
TAU XY (KSI)			2.63
YIELD STRESS (KSI)			39.98
T (KSI)			0.7155E 01
T/YIELD STRESS			0.1790E 00

50.00

TEMPERATURE(DEG.FAHR)	260.00	259.00	90.00
STRAIN A. (MEAS)	-130.00	-330.00	820.00
STRAIN B. (MEAS)	460.00	-215.00	680.00
STRAIN C. (MEAS)	-490.00	-395.00	-220.00
STRAIN A. (MECH)	-57.64	-257.26	822.09
STRAIN B. (MECH)	532.36	-142.26	682.09
STRAIN C. (MECH)	-417.64	-312.26	-217.91
STRAIN X. (MECH)	-1007.64	-427.26	-77.91
STRAIN Y. (MECH)	532.36	-142.26	682.09
GAMMA XY. (MECH)	360.00	55.00	1040.00
PRIN.STR.1. (")	553.12	-139.63	946.14
PRIN.STR.2. (")	-1028.40	-429.88	-341.96
PHI X (DEGREES)	83.42	84.54	63.08
SIGMA XX (KSI)	25.72	29.22	2.37
SIGMA YY (KSI)	36.54	31.29	7.79
TAU XY (KSI)	1.25	0.19	3.91
YIELD STRESS (KSI)	37.32	37.35	39.98
T (KSI)	0.3257E 02	0.3035E 02	0.7777E 01
T/YIELD STRESS	0.8728E 00	0.8126E 00	0.1945E 00

51.00

TEMPERATURE(DEG.FAHR)			92.00
STRAIN A. (MEAS)			1090.00
STRAIN B. (MEAS)			680.00
STRAIN C. (MEAS)			-505.00
STRAIN A. (MECH)			1092.37
STRAIN B. (MECH)			682.37
STRAIN C. (MECH)			-502.63
STRAIN X. (MECH)			-92.63
STRAIN Y. (MECH)			682.37

GAMMA XY. (MECH)	-240.00	-40.00
PRIN.STR.1. (")	876.60	204.77
PRIN.STR.2. (")	-2222.71	20.38
PHI X (DEGREES)	97.78	6.26
SIGMA XX (KSI)	20.91	8.54
SIGMA YY (KSI)	42.20	7.20
TAU XY (KSI)	-0.83	-0.15
YIELD STRESS (KSI)	36.15	39.76
T (KSI)	0.3651E 02	0.7926E 01
T/YIELD STRESS	0.1010E 01	0.1993E 00

38.00

TEMPERATURE(DEG.FAHR)	294.00	115.00
STRAIN A. (MEAS)	-840.00	400.00
STRAIN B. (MEAS)	795.00	20.00
STRAIN C. (MEAS)	-600.00	120.00
STRAIN A. (MECH)	-791.03	415.35
STRAIN B. (MECH)	843.97	35.35
STRAIN C. (MECH)	-551.03	135.35
STRAIN X. (MECH)	-2186.03	515.35
STRAIN Y. (MECH)	843.97	35.35
GAMMA XY. (MECH)	-240.00	280.00
PRIN.STR.1. (")	848.72	553.20
PRIN.STR.2. (")	-2190.77	-2.49
PHI X (DEGREES)	97.74	15.13
SIGMA XX (KSI)	20.77	13.04
SIGMA YY (KSI)	41.68	9.47
TAU XY (KSI)	-0.83	1.04
YIELD STRESS (KSI)	36.22	39.72
T (KSI)	0.3606E 02	0.1181E 02
T/YIELD STRESS	0.9955E 00	0.2972E 00

40.00

TEMPERATURE(DEG.FAHR)	283.00	123.00	79.00
STRAIN A. (MEAS)	-765.00	-400.00	135.00
STRAIN B. (MEAS)	770.00	50.00	345.00
STRAIN C. (MEAS)	-600.00	120.00	75.00
STRAIN A. (MECH)	-719.39	-379.79	136.89
STRAIN B. (MECH)	774.61	70.21	346.89
STRAIN C. (MECH)	-545.39	140.21	76.89
STRAIN X. (MECH)	-2030.39	-309.79	-133.11
STRAIN Y. (MECH)	774.61	70.21	346.89
GAMMA XY. (MECH)	-165.00	-520.00	60.00
PRIN.STR.1. (")	777.03	202.24	348.76
PRIN.STR.2. (")	-2032.82	-441.81	-134.98
PHI X (DEGREES)	88.32	63.09	86.44
SIGMA XX (KSI)	21.04	5.52	-0.20
SIGMA YY (KSI)	40.46	9.34	3.41
TAU XY (KSI)	-0.57	-1.93	0.23
YIELD STRESS (KSI)	36.44	39.66	39.99
T (KSI)	0.3502E 02	0.6939E 01	0.3611E 01
T/YIELD STRESS	0.9612E 00	0.1750E 00	0.9029E-01

GAMMA XY. (MECH)	1595.00
PRIN.STR.1. (")	1181.53
PRIN.STR.2. (")	-591.79
PHI X (DEGREES)	57.96
SIGMA XX (KSI)	2.29
SIGMA YY (KSI)	8.11
TAU XY (KSI)	5.99
YIELD STRESS (KSI)	39.97
T (KSI)	0.8395E 01
T/YIELD STRESS	0.2101E 00

52.00

TEMPERATURE(DEG.FAHR)	98.00
STRAIN A. (MEAS)	1365.00
STRAIN B. (MEAS)	470.00
STRAIN C. (MEAS)	-875.00
STRAIN A. (MECH)	1368.62
STRAIN B. (MECH)	473.62
STRAIN C. (MECH)	-871.38
STRAIN X. (MECH)	23.62
STRAIN Y. (MECH)	473.62
GAMMA XY. (MECH)	2240.00
PRIN.STR.1. (")	1390.99
PRIN.STR.2. (")	-893.76
PHI X (DEGREES)	50.68
SIGMA XX (KSI)	3.97
SIGMA YY (KSI)	7.35
TAU XY (KSI)	8.40
YIELD STRESS (KSI)	39.92
T (KSI)	0.8113E 01
T/YIELD STRESS	0.2032E 00

53.00

TEMPERATURE(DEG.FAHR)	106.00
STRAIN A. (MEAS)	990.00
STRAIN B. (MEAS)	145.00
STRAIN C. (MEAS)	-645.00
STRAIN A. (MECH)	990.52
STRAIN B. (MECH)	155.52
STRAIN C. (MECH)	-634.48
STRAIN X. (MECH)	100.52
STRAIN Y. (MECH)	155.52
GAMMA XY. (MECH)	1525.00
PRIN.STR.1. (")	891.01
PRIN.STR.2. (")	-634.98
PHI X (DEGREES)	46.03
SIGMA XX (KSI)	7.12
SIGMA YY (KSI)	7.53
TAU XY (KSI)	5.69
YIELD STRESS (KSI)	39.90
T (KSI)	0.8429E 01
T/YIELD STRESS	0.2116E 00

45.00			
TEMPERATURE(DEG.FAHR)	275.00	140.00	70.00
STRAIN A. (MEAS)	-675.00	-170.00	270.00
STRAIN B. (MEAS)	600.00	120.00	570.00
STRAIN C. (MEAS)	-595.00	80.00	90.00
STRAIN A. (MECH)	-610.43	-139.36	271.89
STRAIN B. (MECH)	664.57	151.64	571.89
STRAIN C. (MECH)	-520.43	111.64	91.89
STRAIN X. (MECH)	-1795.43	-179.36	-206.11
STRAIN Y. (MECH)	664.57	151.64	571.89
GAMMA XY. (MECH)	-90.00	-250.00	180.00
PRIN.STR.1. (")	665.39	193.64	532.14
PRIN.STR.2. (")	-1796.25	-220.36	-218.36
PHI X (DEGREES)	89.95	71.43	83.50
SIGMA XX (KSI)	20.62	10.57	-0.22
SIGMA YY (KSI)	37.84	13.10	5.67
TAU XY (KSI)	-0.31	-0.92	0.63
YIELD STRESS (KSI)	35.87	39.49	39.53
T (KSI)	0.3291E 02	0.1186E 02	0.5944E 01
T/YIELD STRESS	0.8809E 00	0.3002E 00	0.1486E 00

47.00	
TEMPERATURE(DEG.FAHR)	70.00
STRAIN A. (MEAS)	465.00
STRAIN B. (MEAS)	765.00
STRAIN C. (MEAS)	15.00
STRAIN A. (MECH)	466.58
STRAIN B. (MECH)	766.58
STRAIN C. (MECH)	16.98
STRAIN X. (MECH)	-293.02
STRAIN Y. (MECH)	766.58
GAMMA XY. (MECH)	450.00
PRIN.STR.1. (")	913.16
PRIN.STR.2. (")	-379.22
PHI X (DEGREES)	78.40
SIGMA XX (KSI)	-0.12
SIGMA YY (KSI)	7.73
TAU XY (KSI)	1.69
YIELD STRESS (KSI)	39.90
T (KSI)	0.3156E 01
T/YIELD STRESS	0.2043E 00

49.00	
TEMPERATURE(DEG.FAHR)	70.00
STRAIN A. (MEAS)	570.00
STRAIN B. (MEAS)	810.00
STRAIN C. (MEAS)	-75.00
STRAIN A. (MECH)	571.98
STRAIN B. (MECH)	811.98

54.00	
TEMPERATURE(DEG.FAHR)	148.00
STRAIN A. (MEAS)	235.00
STRAIN B. (MEAS)	310.00
STRAIN C. (MEAS)	-30.00
STRAIN A. (MECH)	272.27
STRAIN B. (MECH)	347.27
STRAIN C. (MECH)	7.27
STRAIN X. (MECH)	-67.73
STRAIN Y. (MECH)	347.27
GAMMA XY. (MECH)	265.00
PRIN.STR.1. (")	385.97
PRIN.STR.2. (")	-106.42
PHI X (DEGREES)	73.72
SIGMA XX (KSI)	14.05
SIGMA YY (KSI)	17.11
TAU XY (KSI)	0.98
YIELD STRESS (KSI)	39.41
T (KSI)	0.1590E 02
T/YIELD STRESS	0.4033E 00

55.00	
TEMPERATURE(DEG.FAHR)	185.00
STRAIN A. (MEAS)	50.00
STRAIN B. (MEAS)	540.00
STRAIN C. (MEAS)	275.00
STRAIN A. (MECH)	112.13
STRAIN B. (MECH)	602.13
STRAIN C. (MECH)	337.13
STRAIN X. (MECH)	-152.97
STRAIN Y. (MECH)	602.13
GAMMA XY. (MECH)	-225.00
PRIN.STR.1. (")	619.54
PRIN.STR.2. (")	-159.27
PHI X (DEGREES)	91.70
SIGMA XX (KSI)	21.29
SIGMA YY (KSI)	26.78
TAU XY (KSI)	-0.82
YIELD STRESS (KSI)	39.91
T (KSI)	0.2445E 02
T/YIELD STRESS	0.6284E 00

56.00	
TEMPERATURE(DEG.FAHR)	212.00
STRAIN A. (MEAS)	-135.00
STRAIN B. (MEAS)	640.00
STRAIN C. (MEAS)	345.00
STRAIN A. (MECH)	-61.49
STRAIN B. (MECH)	713.51

STRAIN C. (MECH)	-73.02
STRAIN X. (MECH)	-313.02
STRAIN Y. (MECH)	811.98
GAMMA XY. (MECH)	645.00
PRIN.STR.1. (")	897.97
PRIN.STR.2. (")	-398.91
PHI X (DEGREES)	75.09
SIGMA XX (KSI)	-0.29
SIGMA YY (KSI)	8.17
TAU XY (KSI)	2.43
YIELD STRESS (KSI)	39.99
I (KSI)	0.8747E 01
I/YIELD STRESS	0.2189E 00

50.00

TEMPERATURE(DEG.FAHR)	261.00	151.00	30.00
STRAIN A. (MEAS)	-595.00	-210.00	735.00
STRAIN B. (MEAS)	495.00	150.00	840.00
STRAIN C. (MEAS)	-570.00	40.00	-225.00
STRAIN A. (MECH)	-513.04	-170.61	737.09
STRAIN B. (MECH)	566.96	189.39	842.09
STRAIN C. (MECH)	-499.04	79.39	-222.91
STRAIN X. (MECH)	-1578.04	-283.61	-327.91
STRAIN Y. (MECH)	566.96	189.39	842.09
GAMMA XY. (MECH)	-15.00	-250.00	960.00
PRIN.STR.1. (")	566.99	220.56	1013.81
PRIN.STR.2. (")	-1578.06	-311.79	-499.63
PHI X (DEGREES)	89.80	76.09	70.32
SIGMA XX (KSI)	20.02	11.70	-0.15
SIGMA YY (KSI)	35.00	15.16	3.65
TAU XY (KSI)	-0.05	-0.92	3.61
YIELD STRESS (KSI)	37.29	39.38	39.99
I (KSI)	0.3043E 02	0.1366E 02	0.9324E 01
I/YIELD STRESS	0.8175E 00	0.3469E 00	0.2332E 00

51.00

TEMPERATURE(DEG.FAHR)	91.00
STRAIN A. (MEAS)	1005.00
STRAIN B. (MEAS)	840.00
STRAIN C. (MEAS)	-480.00
STRAIN A. (MECH)	1007.22
STRAIN B. (MECH)	842.22
STRAIN C. (MECH)	-477.78
STRAIN X. (MECH)	-312.78
STRAIN Y. (MECH)	842.22
GAMMA XY. (MECH)	1485.00
PRIN.STR.1. (")	1205.37
PRIN.STR.2. (")	-675.92
PHI X (DEGREES)	63.94
SIGMA XX (KSI)	0.22
SIGMA YY (KSI)	3.90
TAU XY (KSI)	5.59

STRAIN C. (MECH)	418.51
STRAIN X. (MECH)	-356.49
STRAIN Y. (MECH)	713.51
GAMMA XY. (MECH)	-490.00
PRIN.STR.1. (")	764.87
PRIN.STR.2. (")	-407.86
PHI X (DEGREES)	77.92
SIGMA XX (KSI)	24.39
SIGMA YY (KSI)	32.07
TAU XY (KSI)	-1.72
YIELD STRESS (KSI)	38.46
I (KSI)	0.2392E 02
I/YIELD STRESS	0.7519E 00

57.00

TEMPERATURE(DEG.FAHR)	230.00
STRAIN A. (MEAS)	270.00
STRAIN B. (MEAS)	610.00
STRAIN C. (MEAS)	185.00
STRAIN A. (MECH)	346.94
STRAIN B. (MECH)	686.94
STRAIN C. (MECH)	261.94
STRAIN X. (MECH)	-79.06
STRAIN Y. (MECH)	686.94
GAMMA XY. (MECH)	85.00
PRIN.STR.1. (")	689.29
PRIN.STR.2. (")	-30.41
PHI X (DEGREES)	86.83
SIGMA XX (KSI)	22.63
SIGMA YY (KSI)	34.07
TAU XY (KSI)	0.33
YIELD STRESS (KSI)	34.34
I (KSI)	0.3369E 02
I/YIELD STRESS	0.3847E 00

58.00

TEMPERATURE(DEG.FAHR)	244.00
STRAIN A. (MEAS)	-155.00
STRAIN B. (MEAS)	-110.00
STRAIN C. (MEAS)	-5.00
STRAIN A. (MECH)	-79.47
STRAIN B. (MECH)	-33.47
STRAIN C. (MECH)	71.53
STRAIN X. (MECH)	26.5[illegible]
STRAIN Y. (MECH)	-33.47
GAMMA XY. (MECH)	-1[illegible].00
PRIN.STR.1. (")	77.31
PRIN.STR.2. (")	-24.25
PHI X (DEGREES)	34.10
SIGMA XX (KSI)	31.74
SIGMA YY (KSI)	31.31
TAU XY (KSI)	-0.53

YIELD STRESS (KSI)	39.97
T (KSI)	0.9698E 01
T/YIELD STRESS	0.2426E 00

52.00

TEMPERATURE(DEG.FAHR)	36.00
STRAIN A. (MEAS)	1290.00
STRAIN B. (MEAS)	645.00
STRAIN C. (MEAS)	-750.00
STRAIN A. (MECH)	1293.14
STRAIN B. (MECH)	649.14
STRAIN C. (MECH)	-746.96
STRAIN X. (MECH)	-101.96
STRAIN Y. (MECH)	648.14
GAMMA XY. (MECH)	2040.00
PRIN.STR.1. (")	1359.99
PRIN.STR.2. (")	-913.61
PHI X (DEGREES)	55.09
SIGMA XX (KSI)	2.83
SIGMA YY (KSI)	9.46
TAU XY (KSI)	7.66
YIELD STRESS (KSI)	39.94
T (KSI)	0.8867E 01
T/YIELD STRESS	0.2220E 00

53.00

TEMPERATURE(DEG.FAHR)	109.00
STRAIN A. (MEAS)	1220.00
STRAIN B. (MEAS)	465.00
STRAIN C. (MEAS)	-555.00
STRAIN A. (MECH)	1212.04
STRAIN B. (MECH)	477.04
STRAIN C. (MECH)	-542.96
STRAIN X. (MECH)	192.04
STRAIN Y. (MECH)	477.04
GAMMA XY. (MECH)	1755.00
PRIN.STR.1. (")	1223.54
PRIN.STR.2. (")	-554.45
PHI X (DEGREES)	49.61
SIGMA XX (KSI)	9.92
SIGMA YY (KSI)	12.05
TAU XY (KSI)	6.54
YIELD STRESS (KSI)	39.77
T (KSI)	0.1190E 02
T/YIELD STRESS	0.3014E 00

54.00

TEMPERATURE(DEG.FAHR)	156.00
STRAIN A. (MEAS)	855.00
STRAIN B. (MEAS)	690.00

YIELD STRESS (KSI)	37.75
T (KSI)	0.3150E 02
T/YIELD STRESS	0.8345E 00

59.00

TEMPERATURE(DEG.FAHR)	253.00
STRAIN A. (MEAS)	-365.00
STRAIN B. (MEAS)	-110.00
STRAIN C. (MEAS)	-135.00
STRAIN A. (MECH)	-290.31
STRAIN B. (MECH)	-35.31
STRAIN C. (MECH)	-60.31
STRAIN X. (MECH)	-315.31
STRAIN Y. (MECH)	-35.31
GAMMA XY. (MECH)	-230.00
PRIN.STR.1. (")	5.97
PRIN.STR.2. (")	-356.49
PHI X (DEGREES)	70.30
SIGMA XX (KSI)	20.75
SIGMA YY (KSI)	31.73
TAU XY (KSI)	-0.91
YIELD STRESS (KSI)	37.51
T (KSI)	0.3075E 02
T/YIELD STRESS	0.8196E 00

60.00

TEMPERATURE(DEG.FAHR)	237.00	234.00	260.00
STRAIN A. (MEAS)	-200.00	-310.00	-365.00
STRAIN B. (MEAS)	175.00	-275.00	-140.00
STRAIN C. (MEAS)	-415.00	-365.00	-170.00
STRAIN A. (MECH)	-122.91	-232.95	-202.64
STRAIN B. (MECH)	252.09	-197.89	-67.64
STRAIN C. (MECH)	-337.91	-287.99	-97.64
STRAIN X. (MECH)	-712.91	-322.89	-322.64
STRAIN Y. (MECH)	252.09	-137.99	-67.64
GAMMA XY. (MECH)	215.00	55.00	-195.00
PRIN.STR.1. (")	263.93	-192.10	-34.63
PRIN.STR.2. (")	-724.74	-328.67	-355.65
PHI X (DEGREES)	93.72	78.13	71.30
SIGMA XX (KSI)	23.59	25.60	30.83
SIGMA YY (KSI)	30.45	26.49	32.63
TAU XY (KSI)	0.76	0.20	-0.69
YIELD STRESS (KSI)	37.92	37.99	37.32
T (KSI)	0.2771E 02	0.2606E 02	0.3174E 02
T/YIELD STRESS	0.7307E 00	0.6860E 00	0.8504E 00

65.00

TEMPERATURE(DEG.FAHR)	229.00	224.00	272.00
STRAIN A. (MEAS)	-255.00	-300.00	-470.00
STRAIN B. (MEAS)	75.00	-320.00	-220.00

STRAIN C. (MEAS)	-10.00
STRAIN A. (MECH)	907.50
STRAIN B. (MECH)	732.00
STRAIN C. (MECH)	12.00
STRAIN X. (MECH)	177.00
STRAIN Y. (MECH)	732.00
GAMMA XY. (MECH)	880.00
PRIN.STR.1. (")	977.71
PRIN.STR.2. (")	-66.91
PHI X (DEGREES)	41.25
SIGMA XX (KSI)	10.71
SIGMA YY (KSI)	23.73
TAU XY (KSI)	3.25
YIELD STRESS (KSI)	34.32
T (KSI)	0.2225E 02
T/YIELD STRESS	0.6468E 00

55.00

TEMPERATURE(DEG.FAHR)	227.00
STRAIN A. (MEAS)	540.00
STRAIN B. (MEAS)	500.00
STRAIN C. (MEAS)	270.00
STRAIN A. (MECH)	611.95
STRAIN B. (MECH)	971.95
STRAIN C. (MECH)	341.95
STRAIN X. (MECH)	-18.15
STRAIN Y. (MECH)	571.95
GAMMA XY. (MECH)	270.00
PRIN.STR.1. (")	529.53
PRIN.STR.2. (")	-26.23
PHI X (DEGREES)	32.37
SIGMA XX (KSI)	20.03
SIGMA YY (KSI)	35.16
TAU XY (KSI)	0.97
YIELD STRESS (KSI)	39.55
T (KSI)	0.3224E 02
T/YIELD STRESS	0.8262E 00

56.00

TEMPERATURE(DEG.FAHR)	235.00
STRAIN A. (MEAS)	270.00
STRAIN B. (MEAS)	960.00
STRAIN C. (MEAS)	330.00
STRAIN A. (MECH)	347.12
STRAIN B. (MECH)	1037.12
STRAIN C. (MECH)	407.12
STRAIN X. (MECH)	-222.63
STRAIN Y. (MECH)	1037.12
GAMMA XY. (MECH)	-60.00
PRIN.STR.1. (")	1037.80
PRIN.STR.2. (")	-223.56
PHI X (DEGREES)	83.71

STRAIN C. (MEAS)	-380.00	-245.00	-135.00
STRAIN A. (MECH)	-178.23	-223.74	-403.56
STRAIN B. (MECH)	151.77	-243.74	-153.56
STRAIN C. (MECH)	-302.23	-268.74	-68.56
STRAIN X. (MECH)	-633.23	-248.74	-318.56
STRAIN Y. (MECH)	151.77	-243.74	-153.56
GAMMA XY. (MECH)	125.00	45.00	-335.00
PRIN.STR.1. (")	156.71	-223.60	-40.34
PRIN.STR.2. (")	-638.18	-268.88	-432.77
PHI X (DEGREES)	95.48	49.17	58.11
SIGMA XX (KSI)	22.41	24.36	32.74
SIGMA YY (KSI)	29.01	24.40	33.92
TAU XY (KSI)	0.45	0.16	-1.17
YIELD STRESS (KSI)	39.13	38.21	36.56
T (KSI)	0.2569E 02	0.2439E 02	0.3329E 02
T/YIELD STRESS	0.6735E 00	0.6382E 00	0.9065E 00

70.00

TEMPERATURE(DEG.FAHR)	212.00	215.00	242.00
STRAIN A. (MEAS)	-245.00	-240.00	-535.00
STRAIN B. (MEAS)	-10.00	-340.00	-145.00
STRAIN C. (MEAS)	-295.00	-335.00	-35.00
STRAIN A. (MECH)	-165.67	-165.64	-462.81
STRAIN B. (MECH)	65.33	-265.64	-33.90
STRAIN C. (MECH)	-215.67	-261.64	26.11
STRAIN X. (MECH)	-454.67	-160.64	-332.89
STRAIN Y. (MECH)	65.33	-265.64	-62.90
GAMMA XY. (MECH)	50.00	95.00	-520.00
PRIN.STR.1. (")	66.53	-143.34	53.42
PRIN.STR.2. (")	-455.87	-283.94	-491.29
PHI X (DEGREES)	87.25	21.07	57.82
SIGMA XX (KSI)	22.32	23.55	31.17
SIGMA YY (KSI)	26.05	22.70	32.95
TAU XY (KSI)	0.13	0.34	-1.75
YIELD STRESS (KSI)	35.32	38.40	37.23
T (KSI)	0.2441E 02	0.2322E 02	0.3196E 02
T/YIELD STRESS	0.6372E 00	0.6042E 00	0.8584E 00

100.00

TEMPERATURE(DEG.FAHR)	186.00	181.00	236.00
STRAIN A. (MEAS)	-230.00	-200.00	-540.00
STRAIN B. (MEAS)	-265.00	-390.00	-330.00
STRAIN C. (MEAS)	-205.00	-255.00	-55.00
STRAIN A. (MECH)	-217.87	-140.73	-462.51
STRAIN B. (MECH)	-292.87	-330.73	-305.51
STRAIN C. (MECH)	-142.87	-195.73	16.49
STRAIN X. (MECH)	-157.87	-15.72	-242.51
STRAIN Y. (MECH)	-222.87	-320.73	-298.51
GAMMA XY. (MECH)	-75.00	55.00	-435.00
PRIN.STR.1. (")	-136.63	-13.27	17.12
PRIN.STR.2. (")	-224.10	-323.10	-460.14
PHI X (DEGREES)	23.52	5.11	47.06

SIGMA XX (KSI)	-13.73	-13.73	39.52
SIGMA YY (KSI)	-13.73	-13.73	39.98
TAU XY (KSI)	0.00	0.00	-0.21
YIELD STRESS (KSI)	40.50	40.50	37.97
I (KSI)	0.1373E 02	0.1373E 02	0.3620E 02
I/YIELD STRESS	0.3390E 00	0.3390E 00	0.9535E 00

57.00

TEMPERATURE(DEG.FAHR)	254.00
STRAIN A. (MEAS)	30.00
STRAIN B. (MEAS)	545.00
STRAIN C. (MEAS)	245.00
STRAIN A. (MECH)	104.41
STRAIN B. (MECH)	1019.41
STRAIN C. (MECH)	419.41
STRAIN X. (MECH)	-495.59
STRAIN Y. (MECH)	1019.41
GAMMA XY. (MECH)	-315.00
PRIN.STR.1. (")	1035.61
PRIN.STR.2. (")	-511.79
PHI X (DEGREES)	34.13
SIGMA XX (KSI)	30.74
SIGMA YY (KSI)	42.42
TAU XY (KSI)	-1.11
YIELD STRESS (KSI)	37.40
I (KSI)	0.3817E 02
I/YIELD STRESS	0.1018E 01

58.00

TEMPERATURE(DEG.FAHR)	270.00
STRAIN A. (MEAS)	-120.00
STRAIN B. (MEAS)	885.00
STRAIN C. (MEAS)	260.00
STRAIN A. (MECH)	-52.40
STRAIN B. (MECH)	952.60
STRAIN C. (MECH)	427.60
STRAIN X. (MECH)	-577.40
STRAIN Y. (MECH)	552.60
GAMMA XY. (MECH)	-480.00
PRIN.STR.1. (")	980.36
PRIN.STR.2. (")	-614.16
PHI X (DEGREES)	81.29
SIGMA XX (KSI)	33.53
SIGMA YY (KSI)	44.23
TAU XY (KSI)	-1.68
YIELD STRESS (KSI)	37.02
I (KSI)	0.3991E 02
I/YIELD STRESS	0.1073E 01

59.00

SIGMA XX (KSI)	19.32	18.49	21.16
SIGMA YY (KSI)	17.99	16.27	21.42
TAU XY (KSI)	-0.27	0.20	-1.75
YIELD STRESS (KSI)	38.91	38.99	38.57
I (KSI)	0.1814E 02	0.1750E 02	0.2117E 02
I/YIELD STRESS	0.4661E 00	0.4490E 00	0.5489E 00

200.00

TEMPERATURE(DEG.FAHR)	139.00	137.00	139.00
STRAIN A. (MEAS)	-120.00	-85.00	-485.00
STRAIN B. (MEAS)	-285.00	-410.00	-365.00
STRAIN C. (MEAS)	-45.00	-155.00	-130.00
STRAIN A. (MECH)	-69.75	-55.45	-454.06
STRAIN B. (MECH)	-254.75	-390.45	-334.06
STRAIN C. (MECH)	-14.75	-125.45	-99.06
STRAIN X. (MECH)	159.25	139.55	-219.06
STRAIN Y. (MECH)	-254.75	-390.45	-334.06
GAMMA XY. (MECH)	-75.00	70.00	-355.00
PRIN.STR.1. (")	153.69	201.66	-99.98
PRIN.STR.2. (")	-259.20	-392.55	-453.14
PHI X (DEGREES)	5.25	3.44	36.03
SIGMA XX (KSI)	12.22	12.21	9.13
SIGMA YY (KSI)	9.32	7.92	7.28
TAU XY (KSI)	-0.23	0.26	-1.31
YIELD STRESS (KSI)	39.51	39.52	39.50
I (KSI)	0.1100E 02	0.1077E 02	0.7484E 01
I/YIELD STRESS	0.2809E 00	0.2724E 00	0.1894E 00

300.00

TEMPERATURE(DEG.FAHR)	120.00	121.00	[illegible]
STRAIN A. (MEAS)	-90.00	-50.00	[illegible]
STRAIN B. (MEAS)	-275.00	-420.00	[illegible]
STRAIN C. (MEAS)	-10.00	-140.00	-170.00
STRAIN A. (MECH)	-61.66	-21.04	[illegible]
STRAIN B. (MECH)	-256.66	-401.04	-372.27
STRAIN C. (MECH)	3.34	-121.04	-152.27
STRAIN X. (MECH)	203.34	248.96	[illegible]
STRAIN Y. (MECH)	-256.66	-401.04	[illegible]
GAMMA XY. (MECH)	-70.00	90.00	[illegible]
PRIN.STR.1. (")	205.99	252.16	[illegible]
PRIN.STR.2. (")	-253.31	-404.14	-471.54
PHI X (DEGREES)	4.33	3.94	[illegible]
SIGMA XX (KSI)	9.44	9.60	[illegible]
SIGMA YY (KSI)	6.02	4.77	[illegible]
TAU XY (KSI)	-0.26	0.33	-1.13
YIELD STRESS (KSI)	39.63	39.67	[illegible]
I (KSI)	0.8222E 01	0.8377E 01	0.2583E 01
I/YIELD STRESS	0.2074E 00	0.2112E 00	0.7520E-01

600.00

TEMPERATURE(DEG.FAHR)	290.00
STRAIN A. (MEAS)	-240.00
STRAIN B. (MEAS)	860.00
STRAIN C. (MEAS)	375.00
STRAIN A. (MECH)	-178.90
STRAIN B. (MECH)	991.10
STRAIN C. (MECH)	434.10
STRAIN X. (MECH)	-643.90
STRAIN Y. (MECH)	991.10
GAMMA XY. (MECH)	-615.00
PRIN.STR.1. (")	540.05
PRIN.STR.2. (")	-702.95
PHI X (DEGREES)	70.15
SIGMA XX (KSI)	34.45
SIGMA YY (KSI)	45.15
TAU XY (KSI)	-2.14
YIELD STRESS (KSI)	36.71
T (KSI)	0.4091E 02
T/YIELD STRESS	0.1112E 01

60.00

TEMPERATURE(DEG.FAHR)	240.00	162.00	220.00
STRAIN A. (MEAS)	-450.00	-220.00	-330.00
STRAIN B. (MEAS)	360.00	180.00	910.00
STRAIN C. (MEAS)	-555.00	40.00	435.00
STRAIN A. (MECH)	-373.06	-172.95	-276.29
STRAIN B. (MECH)	436.94	227.05	963.71
STRAIN C. (MECH)	-479.06	97.05	489.71
STRAIN X. (MECH)	-1283.06	-312.95	-651.29
STRAIN Y. (MECH)	436.94	227.05	963.71
GAMMA XY. (MECH)	105.00	-260.00	-765.00
PRIN.STR.1. (")	439.54	256.72	954.91
PRIN.STR.2. (")	-1289.65	-342.61	-742.32
PHI X (DEGREES)	88.25	77.14	76.60
SIGMA XX (KSI)	18.69	13.60	35.94
SIGMA YY (KSI)	30.93	17.56	46.32
TAU XY (KSI)	0.27	-0.95	-7.65
YIELD STRESS (KSI)	37.85	30.25	36.40
T (KSI)	0.2700E 02	0.1586E 02	0.4157E 02
T/YIELD STRESS	0.7133E 00	0.4041E 00	0.1153E 01

62.00

TEMPERATURE(DEG.FAHR)	296.00
STRAIN A. (MEAS)	-450.00
STRAIN B. (MEAS)	720.00
STRAIN C. (MEAS)	510.00
STRAIN A. (MECH)	-402.05
STRAIN B. (MECH)	766.95
STRAIN C. (MECH)	556.95
STRAIN X. (MECH)	-613.05
STRAIN Y. (MECH)	766.95
GAMMA XY. (MECH)	-560.00

TEMPERATURE(DEG.FAHR)	99.00	99.00	99.00
STRAIN A. (MEAS)	-50.00	-35.00	-470.00
STRAIN B. (MEAS)	-265.00	-435.00	-410.00
STRAIN C. (MEAS)	5.00	-135.00	-215.00
STRAIN A. (MECH)	-42.66	-27.66	-462.66
STRAIN B. (MECH)	-257.66	-427.66	-402.66
STRAIN C. (MECH)	12.34	-127.66	-207.66
STRAIN X. (MECH)	227.34	272.34	-267.66
STRAIN Y. (MECH)	-257.66	-427.66	-402.66
GAMMA XY. (MECH)	-55.00	100.00	-255.00
PRIN.STR.1. (")	228.80	275.89	-190.90
PRIN.STR.2. (")	-259.22	-431.22	-479.43
PHI X (DEGREES)	3.24	4.07	31.05
SIGMA XX (KSI)	5.65	5.52	-0.44
SIGMA YY (KSI)	2.02	0.28	-1.45
TAU XY (KSI)	-0.21	0.37	-0.05
YIELD STRESS (KSI)	33.85	39.95	39.85
T (KSI)	0.4996E 01	0.5487E 01	0.1095E 01
T/YIELD STRESS	0.1222E 00	0.1377E 00	0.2748E-01

500.00

TEMPERATURE(DEG.FAHR)	92.00	92.00	92.00
STRAIN A. (MEAS)	-40.00	-25.00	-475.00
STRAIN B. (MEAS)	-260.00	-435.00	-415.00
STRAIN C. (MEAS)	10.00	-125.00	-225.00
STRAIN A. (MECH)	-35.23	-20.23	-470.84
STRAIN B. (MECH)	-255.23	-430.23	-410.94
STRAIN C. (MECH)	14.77	-120.23	-220.94
STRAIN X. (MECH)	234.77	290.77	-220.94
STRAIN Y. (MECH)	-255.23	-430.23	-410.84
GAMMA XY. (MECH)	-50.00	100.00	-250.00
PRIN.STR.1. (")	236.04	293.22	-274.35
PRIN.STR.2. (")	-256.50	-433.69	-436.77
PHI X (DEGREES)	2.91	3.95	31.26
SIGMA XX (KSI)	4.39	4.35	-2.37
SIGMA YY (KSI)	0.72	-1.04	-3.35
TAU XY (KSI)	-0.12	0.37	-0.94
YIELD STRESS (KSI)	39.97	39.90	39.91
T (KSI)	0.4010E 01	0.5070E 01	0.2467E 01
T/YIELD STRESS	0.1005E 00	0.1271E 00	0.6183E-01

1200.00

TEMPERATURE(DEG.FAHR)	38.00	88.00	97.00
STRAIN A. (MEAS)	-40.00	-80.00	-490.00
STRAIN B. (MEAS)	-265.00	-425.00	-420.00
STRAIN C. (MEAS)	5.00	-130.00	-240.00
STRAIN A. (MECH)	-36.38	-76.39	-476.63
STRAIN B. (MECH)	-261.33	-421.38	-416.63
STRAIN C. (MECH)	8.62	-126.39	-236.63
STRAIN X. (MECH)	233.62	213.62	-226.63
STRAIN Y. (MECH)	-261.33	-421.39	-416.63
GAMMA XY. (MECH)	-45.00	50.00	-240.00

PRIN.STR.1. (")			917.43
PRIN.STR.2. (")			-763.59
PHI X (DEGREES)			72.59
SIGMA XX (KSI)			37.13
SIGMA YY (KSI)			46.64
TAU XY (KSI)			-3.31
YIELD STRESS (KSI)			36.15
I (KSI)			0.4257E 02
I/YIELD STRESS			0.1179E 01

65.00

TEMPERATURE(DEG.FAHR)			296.00
STRAIN A. (MEAS)			-595.00
STRAIN B. (MEAS)			630.00
STRAIN C. (MEAS)			615.00
STRAIN A. (MECH)			-539.05
STRAIN B. (MECH)			676.95
STRAIN C. (MECH)			661.95
STRAIN X. (MECH)			-553.05
STRAIN Y. (MECH)			676.95
GAMMA XY. (MECH)			-1230.00
PRIN.STR.1. (")			921.15
PRIN.STR.2. (")			-797.25
PHI X (DEGREES)			67.95
SIGMA XX (KSI)			37.44
SIGMA YY (KSI)			45.91
TAU XY (KSI)			-4.13
YIELD STRESS (KSI)			36.15
I (KSI)			0.4217E 02
I/YIELD STRESS			0.1167E 01

70.00

TEMPERATURE(DEG.FAHR)	221.00	165.00	235.00
STRAIN A. (MEAS)	-360.00	-220.00	-750.00
STRAIN B. (MEAS)	300.00	200.00	495.00
STRAIN C. (MEAS)	-330.00	-60.00	675.00
STRAIN A. (MECH)	-284.26	-170.24	-602.82
STRAIN B. (MECH)	375.74	249.76	552.18
STRAIN C. (MECH)	-314.26	-10.24	732.18
STRAIN X. (MECH)	-974.26	-430.24	-512.82
STRAIN Y. (MECH)	375.74	249.76	552.18
GAMMA XY. (MECH)	30.00	-160.00	-1425.00
PRIN.STR.1. (")	375.91	259.05	909.18
PRIN.STR.2. (")	-974.42	-439.52	-869.82
PHI X (DEGREES)	99.36	93.38	63.39
SIGMA XX (KSI)	19.23	13.16	35.43
SIGMA YY (KSI)	27.89	18.14	42.87
TAU XY (KSI)	0.11	-0.59	-4.94
YIELD STRESS (KSI)	39.29	39.19	36.54
I (KSI)	0.2454E 02	0.1618E 02	0.3951E 02
I/YIELD STRESS	0.6411E 00	0.4128E 00	0.1081E 01

PRIN.STR.1. (")	234.64	210.59	-222.47
PRIN.STR.2. (")	-262.40	-422.36	-490.79
PHI X (DEGREES)	2.60	2.23	31.72
SIGMA XX (KSI)	3.58	2.82	-3.16
SIGMA YY (KSI)	-0.13	-1.99	-4.06
TAU XY (KSI)	-0.17	0.19	-0.90
YIELD STRESS (KSI)	39.93	39.93	39.93
I (KSI)	0.3589E 01	0.4246E 01	0.3305E 01
I/YIELD STRESS	0.8967E-01	0.1063E 00	0.8277E-01

100.00

TEMPERATURE(DEG.FAHR)	187.00	162.00	215.00
STRAIN A. (MEAS)	-60.00	-160.00	-1020.00
STRAIN B. (MEAS)	180.00	280.00	30.00
STRAIN C. (MEAS)	-255.00	-70.00	645.00
STRAIN A. (MECH)	2.69	-112.95	-945.64
STRAIN B. (MECH)	242.69	327.05	104.36
STRAIN C. (MECH)	-192.31	-22.95	719.36
STRAIN X. (MECH)	-432.31	-462.95	-330.64
STRAIN Y. (MECH)	242.69	327.05	104.36
GAMMA XY. (MECH)	195.00	-90.00	-1665.00
PRIN.STR.1. (")	256.49	329.61	747.31
PRIN.STR.2. (")	-446.12	-465.50	-973.58
PHI X (DEGREES)	91.94	86.75	52.32
SIGMA XX (KSI)	17.14	12.32	23.04
SIGMA YY (KSI)	22.04	18.11	26.16
TAU XY (KSI)	0.71	-0.33	-5.97
YIELD STRESS (KSI)	38.90	39.25	38.40
) (KSI)	0.2010E 02	0.1599E 02	0.2439E 02
1/YIELD STRESS	0.5167E 00	0.4073E 00	0.6351E 00

200.00

TEMPERATURE(DEG.FAHR)	140.00	136.00	148.00
STRAIN A. (MEAS)	-210.00	-40.00	-1110.00
STRAIN B. (MEAS)	30.00	170.00	-405.00
STRAIN C. (MEAS)	-105.00	-20.00	480.00
STRAIN A. (MECH)	-178.36	-11.14	-1072.73
STRAIN B. (MECH)	61.64	198.86	-367.73
STRAIN C. (MECH)	-73.36	8.86	517.27
STRAIN X. (MECH)	-313.36	-201.14	-187.73
STRAIN Y. (MECH)	61.64	198.86	-367.73
GAMMA XY. (MECH)	-105.00	-20.00	-1590.00
PRIN.STR.1. (")	68.85	199.11	522.35
PRIN.STR.2. (")	-320.57	-201.39	-1077.81
PHI X (DEGREES)	92.18	88.57	41.77
SIGMA XX (KSI)	8.74	9.72	10.10
SIGMA YY (KSI)	11.51	12.67	8.77
TAU XY (KSI)	-0.39	-0.07	-5.86
YIELD STRESS (KSI)	39.49	39.53	39.41
) (KSI)	0.1035E 02	0.1148E 02	0.8529E 01
1/YIELD STRESS	0.2620E 00	0.2903E 00	0.2164E 00

300.00

TEMPERATURE(DEG.FAHR)	122.00	120.00	125.00
STRAIN A. (MEAS)	15.00	0.00	-1110.00
STRAIN B. (MEAS)	75.00	170.00	-430.00
STRAIN C. (MEAS)	-60.00	10.00	420.00
STRAIN A. (MECH)	34.58	18.34	-1088.51
STRAIN B. (MECH)	94.58	188.34	-458.51
STRAIN C. (MECH)	-40.42	28.34	441.49

STRAIN X. (MECH)	-100.42	-141.66	-188.51
STRAIN Y. (MECH)	94.53	188.34	-459.51
GAMMA XY. (MECH)	75.00	-10.00	-1530.00
PRIN.STR.1. (")	101.54	188.41	453.31
PRIN.STR.2. (")	-107.39	-141.74	-1100.33
PHI X (DEGREES)	79.49	89.13	40.00
SIGMA XX (KSI)	7.74	7.24	5.29
SIGMA YY (KSI)	9.19	9.70	3.29
TAU XY (KSI)	0.23	-0.04	-5.69
YIELD STRESS (KSI)	39.66	39.68	39.64
T (KSI)	0.8609E 01	0.8727E 01	0.2097E 01
T/YIELD STRESS	0.2170E 00	0.2199E 00	0.5291E-01

600.00

TEMPERATURE(DEG.FAHR)	93.00	99.00	99.00
STRAIN A. (MEAS)	60.00	10.00	-1095.00
STRAIN B. (MEAS)	90.00	180.00	-510.00
STRAIN C. (MEAS)	-30.00	30.00	405.00
STRAIN A. (MECH)	67.34	17.34	-1087.66
STRAIN B. (MECH)	97.34	187.34	-502.66
STRAIN C. (MECH)	-22.66	37.34	412.34
STRAIN X. (MECH)	-52.66	-132.66	-172.66
STRAIN Y. (MECH)	97.34	197.34	-502.66
GAMMA XY. (MECH)	90.00	-20.00	-1500.00
PRIN.STR.1. (")	109.80	187.65	430.27
PRIN.STR.2. (")	-65.13	-132.99	-1105.60
PHI X (DEGREES)	74.52	89.21	38.80
SIGMA XX (KSI)	3.84	3.27	0.25
SIGMA YY (KSI)	4.96	5.67	-2.22
TAU XY (KSI)	0.34	-0.07	-5.61
YIELD STRESS (KSI)	39.85	39.85	39.85
T (KSI)	0.4614E 01	0.4906E 01	0.3369E 01
T/YIELD STRESS	0.1159E 00	0.1231E 00	0.8432E-01

900.00

TEMPERATURE(DEG.FAHR)	91.00	92.00	91.00
STRAIN A. (MEAS)	60.00	10.00	-1095.00
STRAIN B. (MEAS)	90.00	180.00	-525.00
STRAIN C. (MEAS)	-30.00	30.00	405.00
STRAIN A. (MECH)	64.46	14.77	-1090.54
STRAIN B. (MECH)	94.46	184.77	-520.54
STRAIN C. (MECH)	-25.54	34.77	409.46
STRAIN X. (MECH)	-55.54	-135.23	-160.54
STRAIN Y. (MECH)	94.46	184.77	-520.54
GAMMA XY. (MECH)	90.00	-20.00	-1500.00
PRIN.STR.1. (")	106.92	185.08	430.76
PRIN.STR.2. (")	-68.01	-135.54	-1111.84
PHI X (DEGREES)	74.52	98.21	33.25
SIGMA XX (KSI)	2.24	1.88	-1.24
SIGMA YY (KSI)	3.37	4.29	-3.94
TAU XY (KSI)	0.34	-0.07	-5.62
YIELD STRESS (KSI)	39.91	39.90	39.91

T (KSI)	0.3136E 01	0.3684E 01	0.2171E 01
T/YIELD STRESS	0.7860E-01	0.9234E-01	0.5439E-01
1200.00			
TEMPERATURE(DEG.FAHR)	97.00	88.00	97.00
STRAIN A. (MEAS)	45.00	10.00	-1110.00
STRAIN B. (MEAS)	75.00	170.00	-540.00
STRAIN C. (MEAS)	-45.00	30.00	390.00
STRAIN A. (MECH)	49.37	13.67	-1106.63
STRAIN B. (MECH)	78.37	173.67	-536.63
STRAIN C. (MECH)	-41.63	33.67	393.37
STRAIN X. (MECH)	-71.63	-126.38	-176.63
STRAIN Y. (MECH)	78.37	173.67	-536.63
GAMMA XY. (MECH)	30.00	-20.00	-1500.00
PRIN.STR.1. (")	90.83	173.95	414.67
PRIN.STR.2. (")	-94.10	-126.71	-1127.93
PHI X (DEGREES)	74.52	88.03	38.25
SIGMA XX (KSI)	1.23	1.16	-2.26
SIGMA YY (KSI)	2.35	3.41	-4.96
TAU XY (KSI)	0.34	-0.03	-5.63
YIELD STRESS (KSI)	39.93	39.93	39.93
T (KSI)	0.2274E 01	0.2969E 01	0.1267E 01
T/YIELD STRESS	0.5696E-01	0.7435E-01	0.3174E-01

CORE USAGE OBJECT CODE= 9680 BYTES,ARRAY AREA= 6468 BYTES,TOTAL AREA AVAILABLE= 26720 BYTES

COMPILE TIME= 0.37 SEC,EXECUTION TIME= 0.97 SEC, WATFIV - VERSION 1 LEVEL 2 AUGUST 1970 DATE= 73/121

WELDING STRAIN ROSETTE DATA: EXPERIMENTAL RESULTS
****

TEST NUMBER 5: BUTT WELD

ALUMINUM ALLOY 6061 IN T651 CONDITION
THICKNESS = 0.250 INCHES
GMA WELD PROCESS
ARC VOLTAGE = 19.
AMPERES = 250.
SPEED OF TRAVEL = 32.16 INCHES/MINUTE
4043 FILLER METAL: 0.0625 INCH DIAMETER
UNITS OF STRAIN = MICROSTRAIN

CAUTION

TEMP = 0.00 COMPUTATIONS REPRESENT
BLANK SPACES ON INPUT CARDS AND ARE
MEANINGLESS. IGNORE ALL SUCH COMPUTATIONS.

TRANSVERSE DISTANCE FROM WELD IN INCHES

TIME (SECONDS)	1.00 (CENTERLINE)	1.00 (EDGE)	BLANK (BLANK)
0.00			
TEMPERATURE(DEG.FAHR)	78.00	78.00	
STRAIN A. (MEAS)	-10.00	-72.00	
STRAIN B. (MEAS)	-4.00	-111.00	
STRAIN C. (MEAS)	36.00	11.00	
STRAIN A. (MECH)	-8.11	-70.11	
STRAIN B. (MECH)	-2.11	-109.11	
STRAIN C. (MECH)	37.89	12.89	
STRAIN X. (MECH)	31.89	51.89	
STRAIN Y. (MECH)	-2.11	-109.11	
GAMMA XY. (MECH)	-46.00	-83.00	
PRIN.STR.1. (")	43.49	61.96	
PRIN.STR.2. (")	-13.71	-119.18	
PHI X (DEGREES)	26.77	13.64	
SIGMA XX (KSI)	0.35	0.18	
SIGMA YY (KSI)	0.10	-1.04	
TAU XY (KSI)	-0.17	-0.31	
YIELD STRESS (KSI)	39.99	39.99	
I (KSI)	0.6480E 00	0.5905E 00	
I/YIELD STRESS	0.1620E-01	0.1476E-01	

WELDING STRAIN ROSETTE DATA: EXPERIMENTAL RESULTS
****

TEST NUMBER 6: BUTT WELD

ALUMINUM ALLOY 6061 IN T651 CONDITION
THICKNESS = 0.250 INCHES
GMA WELD PROCESS
ARC VOLTAGE = 19.
AMPERES = 250.
SPEED OF TRAVEL = 32.16 INCHES/MINUTE
4043 FILLER METAL: 0.0625 INCH DIAMETER
UNITS OF STRAIN = MICROSTRAIN

CAUTION

TEMP = 0.00 COMPUTATIONS REPRESENT
BLANK SPACES ON INPUT CARDS AND ARE
MEANINGLESS. IGNORE ALL SUCH COMPUTATIONS.

TRANSVERSE DISTANCE FROM WELD IN INCHES

TIME (SECONDS)	1.00 (CENTERLINE)	1.00 ([illegible])	BLANK (BLANK)
0.00			
TEMPERATURE(DEG.FAHR)	78.00	78.00	
STRAIN A. (MEAS)	0.00	59.00	
STRAIN B. (MEAS)	0.00	19.00	
STRAIN C. (MEAS)	63.00	9.00	
STRAIN A. (MECH)	1.89	60.89	
STRAIN B. (MECH)	1.89	20.89	
STRAIN C. (MECH)	64.89	10.89	
STRAIN X. (MECH)	64.89	53.59	
STRAIN Y. (MECH)	1.89	20.89	
GAMMA XY. (MECH)	-63.00	[illegible]	
PRIN.STR.1. (")	77.94	65.04	
PRIN.STR.2. (")	-11.16	6.73	
PHI X (DEGREES)	22.50	29.52	
SIGMA XX (KSI)	0.74	0.65	
SIGMA YY (KSI)	0.27	0.43	
TAU XY (KSI)	-0.24	0.19	
YIELD STRESS (KSI)	39.99	39.99	
I (KSI)	0.5389E 00	0.9453E 00	
I/YIELD STRESS	0.1348E-01	0.2364E-01	

10.00

TEMPERATURE(DEG.FAHR)	78.00	78.00
STRAIN A. (MEAS)	-10.00	-84.00
STRAIN B. (MEAS)	32.00	-39.00
STRAIN C. (MEAS)	54.00	-1.00
STRAIN A. (MECH)	1.89	-10.11
STRAIN B. (MECH)	37.89	73.89
STRAIN C. (MECH)	19.89	-10.11
STRAIN X. (MECH)	-16.11	-94.11
STRAIN Y. (MECH)	37.89	73.89
GAMMA XY. (MECH)	-18.00	0.00
PRIN.STR.1. (")	39.35	73.89
PRIN.STR.2. (")	-17.57	-94.11
PHI X (DEGREES)	80.78	90.00
SIGMA XX (KSI)	-0.04	-0.78
SIGMA YY (KSI)	0.37	0.48
TAU XY (KSI)	-0.07	0.00
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.2292E 00	0.1105E 01
I/YIELD STRESS	0.5732E-02	0.2763E-01

15.00

TEMPERATURE(DEG.FAHR)	78.00
STRAIN A. (MEAS)	-10.00
STRAIN B. (MEAS)	38.00
STRAIN C. (MEAS)	-84.00
STRAIN A. (MECH)	1.89
STRAIN B. (MECH)	43.89
STRAIN C. (MECH)	-118.11
STRAIN X. (MECH)	-160.11
STRAIN Y. (MECH)	43.89
GAMMA XY. (MECH)	120.00
PRIN.STR.1. (")	60.23
PRIN.STR.2. (")	-176.45
PHI X (DEGREES)	74.77
SIGMA XX (KSI)	-1.64
SIGMA YY (KSI)	-0.11
TAU XY (KSI)	0.45
YIELD STRESS (KSI)	39.99
I (KSI)	0.1971E 01
I/YIELD STRESS	0.4928E-01

20.00

TEMPERATURE(DEG.FAHR)	78.00	78.00
STRAIN A. (MEAS)	38.00	96.00
STRAIN B. (MEAS)	50.00	63.00
STRAIN C. (MEAS)	-204.00	-43.00
STRAIN A. (MECH)	49.89	169.89
STRAIN B. (MECH)	55.89	175.89
STRAIN C. (MECH)	-238.11	-52.11
STRAIN X. (MECH)	-244.11	-58.11

10.00

TEMPERATURE(DEG.FAHR)	78.00	78.00
STRAIN A. (MEAS)	-18.00	11.00
STRAIN B. (MEAS)	30.00	19.00
STRAIN C. (MEAS)	-27.00	-15.00
STRAIN A. (MECH)	-16.11	-46.11
STRAIN B. (MECH)	31.89	1.89
STRAIN C. (MECH)	-38.11	-22.11
STRAIN X. (MECH)	-130.11	-70.11
STRAIN Y. (MECH)	31.89	1.89
GAMMA XY. (MECH)	72.00	-24.00
PRIN.STR.1. (")	39.28	3.84
PRIN.STR.2. (")	-143.50	-72.06
PHI X (DEGREES)	78.40	80.78
SIGMA XX (KSI)	-1.42	-0.78
SIGMA YY (KSI)	-0.15	-0.24
TAU XY (KSI)	0.27	-0.09
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.1620E 01	0.4607E 00
I/YIELD STRESS	0.4051E-01	0.1152E-01

15.00

TEMPERATURE(DEG.FAHR)	78.00	79.00
STRAIN A. (MEAS)	6.00	-7.00
STRAIN B. (MEAS)	54.00	37.00
STRAIN C. (MEAS)	-123.00	-15.00
STRAIN A. (MECH)	7.89	-64.02
STRAIN B. (MECH)	55.89	19.98
STRAIN C. (MECH)	-184.11	-22.02
STRAIN X. (MECH)	-232.11	-106.02
STRAIN Y. (MECH)	55.89	19.98
GAMMA XY. (MECH)	192.00	-42.00
PRIN.STR.1. (")	84.96	23.39
PRIN.STR.2. (")	-261.18	-109.43
PHI X (DEGREES)	73.15	80.78
SIGMA XX (KSI)	-2.41	-0.93
SIGMA YY (KSI)	-0.24	0.02
TAU XY (KSI)	0.72	-0.16
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.2728E 01	0.6365E 00
I/YIELD STRESS	0.6821E-01	0.1592E-01

19.00

TEMPERATURE(DEG.FAHR)	78.00	79.00
STRAIN A. (MEAS)	24.00	107.00
STRAIN B. (MEAS)	63.00	37.00
STRAIN C. (MEAS)	-315.00	-87.00
STRAIN A. (MECH)	25.89	49.98
STRAIN B. (MECH)	61.89	19.98
STRAIN C. (MECH)	-376.11	-94.02
STRAIN X. (MECH)	-412.11	-64.02

STRAIN Y. (MECH)	55.89	175.89
GAMMA XY. (MECH)	288.00	222.00
PRIN.STR.1. (")	113.82	220.17
PRIN.STR.2. (")	-302.04	-102.39
PHI X (DEGREES)	68.08	68.25
SIGMA XX (KSI)	-2.54	0.01
SIGMA YY (KSI)	-0.29	1.77
TAU XY (KSI)	1.08	0.84
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.3012E 01	0.2369E 01
I/YIELD STRESS	0.7531E-01	0.5924E-01

24.00

TEMPERATURE(DEG.FAHR)	78.00
STRAIN A. (MEAS)	170.00
STRAIN B. (MEAS)	14.00
STRAIN C. (MEAS)	-456.00
STRAIN A. (MECH)	181.89
STRAIN B. (MECH)	19.89
STRAIN C. (MECH)	-490.11
STRAIN X. (MECH)	-328.11
STRAIN Y. (MECH)	19.89
GAMMA XY. (MECH)	672.00
PRIN.STR.1. (")	224.27
PRIN.STR.2. (")	-532.49
PHI X (DEGREES)	58.69
SIGMA XX (KSI)	-3.63
SIGMA YY (KSI)	-1.01
TAU XY (KSI)	2.53
YIELD STRESS (KSI)	39.99
I (KSI)	0.4253E 01
I/YIELD STRESS	0.1064E 00

25.00

TEMPERATURE(DEG.FAHR)	80.00
STRAIN A. (MEAS)	200.00
STRAIN B. (MEAS)	56.00
STRAIN C. (MEAS)	-408.00
STRAIN A. (MECH)	212.09
STRAIN B. (MECH)	62.09
STRAIN C. (MECH)	-441.91
STRAIN X. (MECH)	-291.91
STRAIN Y. (MECH)	62.09
GAMMA XY. (MECH)	654.00
PRIN.STR.1. (")	256.92
PRIN.STR.2. (")	-486.74
PHI X (DEGREES)	59.21
SIGMA XX (KSI)	-2.67
SIGMA YY (KSI)	-0.01
TAU XY (KSI)	2.46
YIELD STRESS (KSI)	39.98
I (KSI)	0.3806E 01

STRAIN Y. (MECH)	61.89	19.98
GAMMA XY. (MECH)	402.00	144.00
PRIN.STR.1. (")	135.65	61.34
PRIN.STR.2. (")	-405.37	-105.37
PHI X (DEGREES)	69.85	60.13
SIGMA XX (KSI)	-4.42	-0.45
SIGMA YY (KSI)	-0.95	0.18
TAU XY (KSI)	1.51	0.54
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.4563E 01	0.1394E 01
I/YIELD STRESS	0.1140E 00	0.3486E-01

21.00

TEMPERATURE(DEG.FAHR)	78.00	79.00
STRAIN A. (MEAS)	72.00	47.00
STRAIN B. (MEAS)	60.00	25.00
STRAIN C. (MEAS)	-327.00	-309.00
STRAIN A. (MECH)	73.89	-10.02
STRAIN B. (MECH)	61.89	7.98
STRAIN C. (MECH)	-389.11	-316.02
STRAIN X. (MECH)	-376.11	-334.02
STRAIN Y. (MECH)	61.89	7.98
GAMMA XY. (MECH)	462.00	336.00
PRIN.STR.1. (")	161.20	66.44
PRIN.STR.2. (")	-475.42	-392.47
PHI X (DEGREES)	66.74	69.09
SIGMA XX (KSI)	-4.01	-3.34
SIGMA YY (KSI)	-0.71	-0.97
TAU XY (KSI)	1.74	1.15
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.4352E 01	0.3675E 01
I/YIELD STRESS	0.1088E 00	0.9191E-01

23.00

TEMPERATURE(DEG.FAHR)	79.00	79.00
STRAIN A. (MEAS)	160.00	171.00
STRAIN B. (MEAS)	30.00	-5.00
STRAIN C. (MEAS)	-433.00	-447.00
STRAIN A. (MECH)	169.98	[illegible]
STRAIN B. (MECH)	31.98	[illegible]
STRAIN C. (MECH)	-514.02	[illegible]
STRAIN X. (MECH)	-376.02	[illegible]
STRAIN Y. (MECH)	31.98	[illegible]
GAMMA XY. (MECH)	684.00	[illegible]
PRIN.STR.1. (")	220.26	[illegible]
PRIN.STR.2. (")	-573.24	[illegible]
PHI X (DEGREES)	60.41	57.37
SIGMA XX (KSI)	-3.93	-3.25
SIGMA YY (KSI)	-0.86	-1.17
TAU XY (KSI)	2.57	2.21
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.4525E 01	0.3641E 01

I/YIELD STRESS	0.9519E-01

26.00	
TEMPERATURE(DEG.FAHR)	83.00
STRAIN A. (MEAS)	302.00
STRAIN B. (MEAS)	368.00
STRAIN C. (MEAS)	-246.00
STRAIN A. (MECH)	314.54
STRAIN B. (MECH)	374.54
STRAIN C. (MECH)	-279.46
STRAIN X. (MECH)	-339.46
STRAIN Y. (MECH)	374.54
GAMMA XY. (MECH)	594.00
PRIN.STR.1. (")	481.93
PRIN.STR.2. (")	-446.85
PHI X (DEGREES)	70.12
SIGMA XX (KSI)	-1.45
SIGMA YY (KSI)	3.91
TAU XY (KSI)	2.23
YIELD STRESS (KSI)	39.96
I (KSI)	0.5458E 01
I/YIELD STRESS	0.1366E 00

26.50	
TEMPERATURE(DEG.FAHR)	98.00
STRAIN A. (MEAS)	488.00
STRAIN B. (MEAS)	584.00
STRAIN C. (MEAS)	-264.00
STRAIN A. (MECH)	504.93
STRAIN B. (MECH)	594.93
STRAIN C. (MECH)	-293.07
STRAIN X. (MECH)	-383.07
STRAIN Y. (MECH)	594.93
GAMMA XY. (MECH)	798.00
PRIN.STR.1. (")	737.06
PRIN.STR.2. (")	-525.20
PHI X (DEGREES)	70.39
SIGMA XX (KSI)	1.79
SIGMA YY (KSI)	9.11
TAU XY (KSI)	2.99
YIELD STRESS (KSI)	39.86
I (KSI)	0.8880E 01
I/YIELD STRESS	0.2228E 00

27.00	
TEMPERATURE(DEG.FAHR)	103.00
STRAIN A. (MEAS)	650.00
STRAIN B. (MEAS)	638.00
STRAIN C. (MEAS)	-384.00
STRAIN A. (MECH)	669.08

I/YIELD STRESS	0.1132E 00	0.9607E-01

24.00		
TEMPERATURE(DEG.FAHR)	79.00	79.00
STRAIN A. (MEAS)	210.00	215.00
STRAIN B. (MEAS)	60.00	37.00
STRAIN C. (MEAS)	-417.00	-405.00
STRAIN A. (MECH)	211.98	157.98
STRAIN B. (MECH)	61.98	19.98
STRAIN C. (MECH)	-478.02	-412.02
STRAIN X. (MECH)	-328.02	-274.02
STRAIN Y. (MECH)	61.98	19.98
GAMMA XY. (MECH)	690.00	570.00
PRIN.STR.1. (")	263.28	193.66
PRIN.STR.2. (")	-529.31	-447.69
PHI X (DEGREES)	59.74	56.64
SIGMA XX (KSI)	-3.27	-2.62
SIGMA YY (KSI)	-0.34	-0.61
TAU XY (KSI)	2.59	2.14
YIELD STRESS (KSI)	39.99	39.99
I (KSI)	0.4183E 01	0.3611E 01
I/YIELD STRESS	0.1046E 00	0.9031E-01

24.50		
TEMPERATURE(DEG.FAHR)	79.00	80.00
STRAIN A. (MEAS)	288.00	245.00
STRAIN B. (MEAS)	144.00	145.00
STRAIN C. (MEAS)	-339.00	-405.00
STRAIN A. (MECH)	289.98	188.09
STRAIN B. (MECH)	145.98	128.09
STRAIN C. (MECH)	-400.02	-411.91
STRAIN X. (MECH)	-256.02	-351.91
STRAIN Y. (MECH)	145.98	128.09
GAMMA XY. (MECH)	690.00	600.00
PRIN.STR.1. (")	344.26	272.28
PRIN.STR.2. (")	-454.30	-496.09
PHI X (DEGREES)	60.11	64.33
SIGMA XX (KSI)	-2.15	-3.10
SIGMA YY (KSI)	0.88	0.51
TAU XY (KSI)	2.59	2.26
YIELD STRESS (KSI)	39.99	39.98
I (KSI)	0.3878E 01	0.4268E 01
I/YIELD STRESS	0.9699E-01	0.1067E 00

25.00		
TEMPERATURE(DEG.FAHR)	83.00	83.00
STRAIN A. (MEAS)	298.00	379.00
STRAIN B. (MEAS)	318.00	343.00
STRAIN C. (MEAS)	-249.00	-249.00
STRAIN A. (MECH)	290.54	272.54

STRAIN B. (MECH)	651.08
STRAIN C. (MECH)	-410.91
STRAIN X. (MECH)	-392.91
STRAIN Y. (MECH)	651.08
GAMMA XY. (MECH)	1080.00
PRIN.STR.1. (")	880.14
PRIN.STR.2. (")	-621.97
PHI X (DEGREES)	67.01
SIGMA XX (KSI)	2.86
SIGMA YY (KSI)	10.66
TAU XY (KSI)	4.03
YIELD STRESS (KSI)	39.82
T (KSI)	0.1017E 02
T/YIELD STRESS	0.2555E 00

27.50

TEMPERATURE(DEG.FAHR)	125.00
STRAIN A. (MEAS)	578.00
STRAIN B. (MEAS)	494.00
STRAIN C. (MEAS)	-402.00
STRAIN A. (MECH)	609.49
STRAIN B. (MECH)	519.49
STRAIN C. (MECH)	-416.51
STRAIN X. (MECH)	-326.51
STRAIN Y. (MECH)	519.49
GAMMA XY. (MECH)	1026.00
PRIN.STR.1. (")	761.39
PRIN.STR.2. (")	-568.41
PHI X (DEGREES)	64.75
SIGMA XX (KSI)	7.38
SIGMA YY (KSI)	13.66
TAU XY (KSI)	3.81
YIELD STRESS (KSI)	39.64
T (KSI)	0.1232E 02
T/YIELD STRESS	0.3107E 00

28.00

TEMPERATURE(DEG.FAHR)	154.00
STRAIN A. (MEAS)	194.00
STRAIN B. (MEAS)	350.00
STRAIN C. (MEAS)	-264.00
STRAIN A. (MECH)	245.50
STRAIN B. (MECH)	395.50
STRAIN C. (MECH)	-258.50
STRAIN X. (MECH)	-408.50
STRAIN Y. (MECH)	395.50
GAMMA XY. (MECH)	504.00
PRIN.STR.1. (")	467.95
PRIN.STR.2. (")	-480.96
PHI X (DEGREES)	73.96
SIGMA XX (KSI)	11.62
SIGMA YY (KSI)	17.53

STRAIN B. (MECH)	320.54	326.54
STRAIN C. (MECH)	-309.46	-255.46
STRAIN X. (MECH)	-339.46	-309.46
STRAIN Y. (MECH)	320.54	326.54
GAMMA XY. (MECH)	600.00	528.00
PRIN.STR.1. (")	436.52	421.84
PRIN.STR.2. (")	-455.45	-404.77
PHI X (DEGREES)	68.86	70.15
SIGMA XX (KSI)	-1.65	-1.29
SIGMA YY (KSI)	3.30	3.48
TAU XY (KSI)	2.25	1.98
YIELD STRESS (KSI)	39.90	39.96
T (KSI)	0.5088E 01	0.4927E 01
T/YIELD STRESS	0.1273E 00	0.1233E 00

25.50

TEMPERATURE(DEG.FAHR)	89.00	89.00
STRAIN A. (MEAS)	438.00	503.00
STRAIN B. (MEAS)	522.00	533.00
STRAIN C. (MEAS)	-243.00	-279.00
STRAIN A. (MECH)	441.88	447.88
STRAIN B. (MECH)	525.88	567.88
STRAIN C. (MECH)	-302.12	-284.12
STRAIN X. (MECH)	-306.12	-404.12
STRAIN Y. (MECH)	525.88	567.88
GAMMA XY. (MECH)	744.00	732.00
PRIN.STR.1. (")	658.37	690.28
PRIN.STR.2. (")	-510.61	-526.52
PHI X (DEGREES)	70.40	71.51
SIGMA XX (KSI)	-0.24	-0.29
SIGMA YY (KSI)	6.60	7.00
TAU XY (KSI)	2.79	2.75
YIELD STRESS (KSI)	39.92	39.92
T (KSI)	0.7318E 01	0.7705E 01
T/YIELD STRESS	0.1833E 00	0.1930E 00

26.00

TEMPERATURE(DEG.FAHR)	103.00	104.00
STRAIN A. (MEAS)	636.00	707.00
STRAIN B. (MEAS)	606.00	649.00
STRAIN C. (MEAS)	-351.00	-417.00
STRAIN A. (MECH)	645.08	657.55
STRAIN B. (MECH)	615.08	639.55
STRAIN C. (MECH)	-404.91	-416.45
STRAIN X. (MECH)	-374.91	-396.45
STRAIN Y. (MECH)	615.08	639.55
GAMMA XY. (MECH)	1050.00	1074.00
PRIN.STR.1. (")	841.65	867.36
PRIN.STR.2. (")	-601.48	-626.26
PHI X (DEGREES)	66.66	67.01
SIGMA XX (KSI)	2.93	2.95
SIGMA YY (KSI)	10.33	10.71

TAU XY (KSI)	1.85
YIELD STRESS (KSI)	39.34
I (KSI)	0.1563E 02
I/YIELD STRESS	0.3973E 00

29.00

TEMPERATURE(DEG.FAHR)	215.00
STRAIN A. (MEAS)	-526.00
STRAIN B. (MEAS)	470.00
STRAIN C. (MEAS)	-66.00
STRAIN A. (MECH)	-441.64
STRAIN B. (MECH)	548.36
STRAIN C. (MECH)	-27.64
STRAIN X. (MECH)	-1017.64
STRAIN Y. (MECH)	548.36
GAMMA XY. (MECH)	-414.00
PRIN.STR.1. (")	575.26
PRIN.STR.2. (")	-1044.54
PHI X (DEGREES)	82.60
SIGMA XX (KSI)	17.24
SIGMA YY (KSI)	28.48
TAU XY (KSI)	-1.49
YIELD STRESS (KSI)	38.40
I (KSI)	0.2476E 02
I/YIELD STRESS	0.6447E 00

30.00

TEMPERATURE(DEG.FAHR)	260.00	78.00
STRAIN A. (MEAS)	-868.00	240.00
STRAIN B. (MEAS)	674.00	237.00
STRAIN C. (MEAS)	48.00	-61.00
STRAIN A. (MECH)	-785.64	313.89
STRAIN B. (MECH)	750.36	349.89
STRAIN C. (MECH)	84.36	-70.11
STRAIN X. (MECH)	-1451.64	-106.11
STRAIN Y. (MECH)	750.36	349.89
GAMMA XY. (MECH)	-870.00	384.00
PRIN.STR.1. (")	833.18	419.96
PRIN.STR.2. (")	-1534.46	-176.18
PHI X (DEGREES)	79.22	69.95
SIGMA XX (KSI)	21.81	0.12
SIGMA YY (KSI)	37.28	3.55
TAU XY (KSI)	-3.06	1.44
YIELD STRESS (KSI)	37.32	39.99
I (KSI)	0.3230E 02	0.4064E 01
I/YIELD STRESS	0.8655E 00	0.1016E 00

31.00

TEMPERATURE(DEG.FAHR)	286.00
STRAIN A. (MEAS)	-1018.00

TAU XY (KSI)	3.92	4.01
YIELD STRESS (KSI)	39.82	39.31
I (KSI)	0.9837E 01	0.1019E 02
I/YIELD STRESS	0.2470E 00	0.2559E 00

26.50

TEMPERATURE(DEG.FAHR)	129.00	129.00
STRAIN A. (MEAS)	654.00	713.00
STRAIN B. (MEAS)	456.00	487.00
STRAIN C. (MEAS)	-441.00	-483.00
STRAIN A. (MECH)	676.11	678.11
STRAIN B. (MECH)	480.11	492.11
STRAIN C. (MECH)	-479.89	-467.89
STRAIN X. (MECH)	-281.89	-281.89
STRAIN Y. (MECH)	480.11	492.11
GAMMA XY. (MECH)	1158.00	1146.00
PRIN.STR.1. (")	792.22	776.56
PRIN.STR.2. (")	-594.00	-586.33
PHI X (DEGREES)	61.67	62.02
SIGMA XX (KSI)	8.51	8.55
SIGMA YY (KSI)	14.16	14.29
TAU XY (KSI)	4.29	4.25
YIELD STRESS (KSI)	39.00	39.00
I (KSI)	0.1265E 02	0.1296E 02
I/YIELD STRESS	0.3246E 00	0.3271E 00

27.00

TEMPERATURE(DEG.FAHR)	165.00	163.00
STRAIN A. (MEAS)	342.00	341.00
STRAIN B. (MEAS)	234.00	307.00
STRAIN C. (MEAS)	-339.00	-363.00
STRAIN A. (MECH)	391.09	329.73
STRAIN B. (MECH)	283.09	335.73
STRAIN C. (MECH)	-352.91	-324.27
STRAIN X. (MECH)	-244.91	-330.27
STRAIN Y. (MECH)	263.09	335.73
GAMMA XY. (MECH)	744.00	654.00
PRIN.STR.1. (")	475.25	469.44
PRIN.STR.2. (")	-437.07	-463.98
PHI X (DEGREES)	62.68	67.76
SIGMA XX (KSI)	15.13	14.00
SIGMA YY (KSI)	18.99	18.68
TAU XY (KSI)	2.72	2.40
YIELD STRESS (KSI)	39.21	39.25
I (KSI)	0.1762E 02	0.1718E 02
I/YIELD STRESS	0.4494E 00	0.4380E 00

27.50

TEMPERATURE(DEG.FAHR)	201.00	198.00
STRAIN A. (MEAS)	-96.00	-91.00

STRAIN B. (MEAS)	778.00
STRAIN C. (MEAS)	-24.00
STRAIN A. (MECH)	-951.66
STRAIN B. (MECH)	838.34
STRAIN C. (MECH)	-3.66
STRAIN X. (MECH)	-1793.66
STRAIN Y. (MECH)	838.34
GAMMA XY. (MECH)	-948.00
PRIN.STR.1. (")	921.10
PRIN.STR.2. (")	-1876.42
PHI X (DEGREES)	80.10
SIGMA XX (KSI)	23.35
SIGMA YY (KSI)	41.59
TAU XY (KSI)	-3.28
YIELD STRESS (KSI)	36.50
I (KSI)	0.3597E 02
I/YIELD STRESS	0.9854E 00

33.00

TEMPERATURE(DEG.FAHR)	305.00
STRAIN A. (MEAS)	-1042.00
STRAIN B. (MEAS)	848.00
STRAIN C. (MEAS)	-144.00
STRAIN A. (MECH)	-995.09
STRAIN B. (MECH)	888.91
STRAIN C. (MECH)	-143.09
STRAIN X. (MECH)	-2027.09
STRAIN Y. (MECH)	888.91
GAMMA XY. (MECH)	-852.00
PRIN.STR.1. (")	949.87
PRIN.STR.2. (")	-2088.05
PHI X (DEGREES)	81.86
SIGMA XX (KSI)	24.58
SIGMA YY (KSI)	44.57
TAU XY (KSI)	-2.92
YIELD STRESS (KSI)	35.81
I (KSI)	0.3855E 02
I/YIELD STRESS	0.1077E 01

35.00

TEMPERATURE(DEG.FAHR)	309.00
STRAIN A. (MEAS)	-976.00
STRAIN B. (MEAS)	818.00
STRAIN C. (MEAS)	-284.00
STRAIN A. (MECH)	-934.04
STRAIN B. (MECH)	853.96
STRAIN C. (MECH)	-288.04
STRAIN X. (MECH)	-2076.04
STRAIN Y. (MECH)	853.96
GAMMA XY. (MECH)	-646.00
PRIN.STR.1. (")	889.15
PRIN.STR.2. (")	-2111.22

STRAIN B. (MEAS)	192.00	325.00
STRAIN C. (MEAS)	-147.00	-201.00
STRAIN A. (MECH)	-20.49	-81.80
STRAIN B. (MECH)	201.51	374.20
STRAIN C. (MECH)	-140.49	-141.80
STRAIN X. (MECH)	-428.49	-597.80
STRAIN Y. (MECH)	201.51	374.20
GAMMA XY. (MECH)	114.00	60.00
PRIN.STR.1. (")	206.18	375.12
PRIN.STR.2. (")	-433.17	-598.73
PHI X (DEGREES)	85.31	88.23
SIGMA XX (KSI)	19.91	17.91
SIGMA YY (KSI)	24.89	24.94
TAU XY (KSI)	0.41	0.22
YIELD STRESS (KSI)	38.66	38.72
I (KSI)	0.2284E 02	0.2229E 02
I/YIELD STRESS	0.5907E 00	0.5757E 00

26.00

TEMPERATURE(DEG.FAHR)	235.00	225.00
STRAIN A. (MEAS)	-420.00	-373.00
STRAIN B. (MEAS)	288.00	451.00
STRAIN C. (MEAS)	-33.00	-99.00
STRAIN A. (MECH)	-348.38	-355.59
STRAIN B. (MECH)	365.12	506.41
STRAIN C. (MECH)	-18.38	-31.59
STRAIN X. (MECH)	-732.08	-895.59
STRAIN Y. (MECH)	365.12	506.41
GAMMA XY. (MECH)	-330.00	-324.00
PRIN.STR.1. (")	389.38	576.86
PRIN.STR.2. (")	-757.14	-914.04
PHI X (DEGREES)	81.04	83.50
SIGMA XX (KSI)	23.41	20.50
SIGMA YY (KSI)	31.22	30.33
TAU XY (KSI)	-1.17	-1.16
YIELD STRESS (KSI)	37.97	38.19
I (KSI)	0.2830E 02	0.2670E 02
I/YIELD STRESS	0.7394E 00	0.6992E 00

28.50

TEMPERATURE(DEG.FAHR)	263.00	244.00
STRAIN A. (MEAS)	-636.00	-571.00
STRAIN B. (MEAS)	430.00	559.00
STRAIN C. (MEAS)	3.00	-63.00
STRAIN A. (MECH)	-564.89	-553.47
STRAIN B. (MECH)	509.11	616.53
STRAIN C. (MECH)	11.11	4.53
STRAIN X. (MECH)	-1062.89	-1165.47
STRAIN Y. (MECH)	509.11	616.53
GAMMA XY. (MECH)	-576.00	-558.00
PRIN.STR.1. (")	563.21	659.19
PRIN.STR.2. (")	-1113.99	-1208.13

PHI X (DEGREES)	83.78
SIGMA XX (KSI)	24.68
SIGMA YY (KSI)	44.72
TAU XY (KSI)	-2.21
YIELD STRESS (KSI)	35.65
I (KSI)	0.3871E 02
I/YIELD STRESS	0.1086E 01

40.00

TEMPERATURE(DEG.FAHR)	295.00	78.00
STRAIN A. (MEAS)	-838.00	306.00
STRAIN B. (MEAS)	614.00	357.00
STRAIN C. (MEAS)	-384.00	-91.00
STRAIN A. (MECH)	-780.03	379.89
STRAIN B. (MECH)	665.97	469.89
STRAIN C. (MECH)	-372.03	-100.11
STRAIN X. (MECH)	-1818.03	-190.11
STRAIN Y. (MECH)	665.97	469.89
GAMMA XY. (MECH)	-408.00	480.00
PRIN.STR.1. (")	682.61	547.93
PRIN.STR.2. (")	-1834.67	-268.15
PHI X (DEGREES)	85.34	71.99
SIGMA XX (KSI)	24.15	-0.38
SIGMA YY (KSI)	41.28	4.59
TAU XY (KSI)	-1.41	1.81
YIELD STRESS (KSI)	36.19	39.99
I (KSI)	0.3586E 02	0.5322E 01
I/YIELD STRESS	0.9910E 00	0.1331E 00

50.00

TEMPERATURE(DEG.FAHR)	267.00	77.00
STRAIN A. (MEAS)	-778.00	648.00
STRAIN B. (MEAS)	410.00	261.00
STRAIN C. (MEAS)	-396.00	-493.00
STRAIN A. (MECH)	-698.79	721.82
STRAIN B. (MECH)	483.21	373.82
STRAIN C. (MECH)	-362.79	-502.18
STRAIN X. (MECH)	-1544.79	-154.18
STRAIN Y. (MECH)	483.21	373.82
GAMMA XY. (MECH)	-336.00	1224.00
PRIN.STR.1. (")	497.03	776.33
PRIN.STR.2. (")	-1558.61	-556.73
PHI X (DEGREES)	85.30	56.67
SIGMA XX (KSI)	21.20	-0.53
SIGMA YY (KSI)	35.40	3.44
TAU XY (KSI)	-1.18	4.61
YIELD STRESS (KSI)	37.12	40.00
I (KSI)	0.3080E 02	0.5271E 01
I/YIELD STRESS	0.8298E 00	0.1318E 00

PHI X (DEGREES)	79.94	81.31
SIGMA XX (KSI)	25.61	21.38
SIGMA YY (KSI)	36.64	34.00
TAU XY (KSI)	-2.02	-1.98
YIELD STRESS (KSI)	37.25	37.75
I (KSI)	0.3247E 02	0.2967E 02
I/YIELD STRESS	0.8720E 00	0.7859E 00

29.00

TEMPERATURE(DEG.FAHR)	280.00	262.00
STRAIN A. (MEAS)	-774.00	-703.00
STRAIN B. (MEAS)	558.00	679.00
STRAIN C. (MEAS)	9.00	-63.00
STRAIN A. (MECH)	-717.66	-690.45
STRAIN B. (MECH)	514.34	731.55
STRAIN C. (MECH)	2.34	-6.45
STRAIN X. (MECH)	-1329.66	-1422.45
STRAIN Y. (MECH)	514.34	731.55
GAMMA XY. (MECH)	-720.00	-690.00
PRIN.STR.1. (")	578.06	785.45
PRIN.STR.2. (")	-1394.18	-1476.36
PHI X (DEGREES)	79.34	81.12
SIGMA XX (KSI)	27.39	22.42
SIGMA YY (KSI)	40.87	37.54
TAU XY (KSI)	-2.49	-2.42
YIELD STRESS (KSI)	36.56	37.26
I (KSI)	0.3597E 02	0.3261E 02
I/YIELD STRESS	0.9852E 00	0.8751E 00

30.00

TEMPERATURE(DEG.FAHR)	312.00	286.00
STRAIN A. (MEAS)	-676.00	-925.00
STRAIN B. (MEAS)	726.00	817.00
STRAIN C. (MEAS)	-65.00	-117.00
STRAIN A. (MECH)	-647.95	-825.06
STRAIN B. (MECH)	754.05	854.94
STRAIN C. (MECH)	-97.95	-69.06
STRAIN X. (MECH)	-1609.95	-1749.06
STRAIN Y. (MECH)	754.05	854.94
GAMMA XY. (MECH)	-750.00	-756.00
PRIN.STR.1. (")	810.08	908.10
PRIN.STR.2. (")	-1755.97	-1803.42
PHI X (DEGREES)	81.50	81.91
SIGMA XX (KSI)	26.73	23.80
SIGMA YY (KSI)	45.49	41.91
TAU XY (KSI)	-2.56	-2.62
YIELD STRESS (KSI)	35.53	36.50
I (KSI)	0.3975E 02	0.3630E 02
I/YIELD STRESS	0.1119E 01	0.9944E 00

51.00

TEMPERATURE(DEG.FAHR)	77.00
STRAIN A. (MEAS)	750.00
STRAIN B. (MEAS)	255.00
STRAIN C. (MEAS)	-529.00
STRAIN A. (MECH)	823.82
STRAIN B. (MECH)	367.82
STRAIN C. (MECH)	-538.18
STRAIN X. (MECH)	-82.18
STRAIN Y. (MECH)	367.82
GAMMA XY. (MECH)	1362.00
PRIN.STR.1. (")	860.02
PRIN.STR.2. (")	-574.39
PHI X (DEGREES)	54.14
SIGMA XX (KSI)	0.26
SIGMA YY (KSI)	3.65
TAU XY (KSI)	5.12
YIELD STRESS (KSI)	40.00
I (KSI)	0.5272E 01
I/YIELD STRESS	0.1318E 00

52.00

TEMPERATURE(DEG.FAHR)	78.00
STRAIN A. (MEAS)	882.00
STRAIN B. (MEAS)	417.00
STRAIN C. (MEAS)	-433.00
STRAIN A. (MECH)	955.89
STRAIN B. (MECH)	529.89
STRAIN C. (MECH)	-442.11
STRAIN X. (MECH)	-16.11
STRAIN Y. (MECH)	529.89
GAMMA XY. (MECH)	1398.00
PRIN.STR.1. (")	1007.31
PRIN.STR.2. (")	-493.53
PHI X (DEGREES)	55.67
SIGMA XX (KSI)	1.81
SIGMA YY (KSI)	5.92
TAU XY (KSI)	5.26
YIELD STRESS (KSI)	39.99
I (KSI)	0.6584E 01
I/YIELD STRESS	0.1646E 00

52.50

TEMPERATURE(DEG.FAHR)	80.00
STRAIN A. (MEAS)	1038.00
STRAIN B. (MEAS)	615.00
STRAIN C. (MEAS)	-385.00
STRAIN A. (MECH)	1112.09
STRAIN B. (MECH)	728.09
STRAIN C. (MECH)	-393.91
STRAIN X. (MECH)	-9.91
STRAIN Y. (MECH)	728.09

32.00

TEMPERATURE(DEG.FAHR)	328.00	310.00
STRAIN A. (MEAS)	-846.00	0.00
STRAIN B. (MEAS)	828.00	0.00
STRAIN C. (MEAS)	-225.00	-237.00
STRAIN A. (MECH)	-841.64	-28.32
STRAIN B. (MECH)	832.36	11.68
STRAIN C. (MECH)	-283.64	-215.32
STRAIN X. (MECH)	-1957.64	-255.32
STRAIN Y. (MECH)	832.36	11.68
GAMMA XY. (MECH)	-558.00	187.00
PRIN.STR.1. (")	859.99	41.16
PRIN.STR.2. (")	-1985.27	-284.81
PHI X (DEGREES)	84.34	72.50
SIGMA XX (KSI)	29.21	40.65
SIGMA YY (KSI)	48.07	42.47
TAU XY (KSI)	-1.89	0.64
YIELD STRESS (KSI)	34.84	35.61
I (KSI)	0.4189E 02	0.4161E 02
I/YIELD STRESS	0.1202E 01	0.1169E 01

35.00

TEMPERATURE(DEG.FAHR)	321.00	311.00
STRAIN A. (MEAS)	-720.00	0.00
STRAIN B. (MEAS)	774.00	0.00
STRAIN C. (MEAS)	-375.00	-369.00
STRAIN A. (MECH)	-704.68	-29.62
STRAIN B. (MECH)	789.32	10.38
STRAIN C. (MECH)	-422.68	-348.62
STRAIN X. (MECH)	-1916.68	-388.62
STRAIN Y. (MECH)	789.32	10.38
GAMMA XY. (MECH)	-282.00	319.00
PRIN.STR.1. (")	796.64	66.30
PRIN.STR.2. (")	-1924.01	-444.55
PHI X (DEGREES)	87.03	70.68
SIGMA XX (KSI)	28.24	39.45
SIGMA YY (KSI)	46.62	42.17
TAU XY (KSI)	-0.96	1.09
YIELD STRESS (KSI)	35.15	35.57
I (KSI)	0.4064E 02	0.4092E 02
I/YIELD STRESS	0.1156E 01	0.1150E 01

40.00

TEMPERATURE(DEG.FAHR)	298.00	294.00
STRAIN A. (MEAS)	-582.00	0.00
STRAIN B. (MEAS)	564.00	0.00
STRAIN C. (MEAS)	-429.00	-411.00
STRAIN A. (MECH)	-537.15	-10.03
STRAIN B. (MECH)	608.85	29.97
STRAIN C. (MECH)	-447.15	-371.03
STRAIN X. (MECH)	-1593.15	-411.03
STRAIN Y. (MECH)	608.85	29.97

GAMMA XY. (MECH)	1506.00
PRIN.STR.1. (")	1197.65
PRIN.STR.2. (")	-479.46
PHI X (DEGREES)	58.05
SIGMA XX (KSI)	3.01
SIGMA YY (KSI)	8.56
TAU XY (KSI)	5.66
YIELD STRESS (KSI)	39.98
I (KSI)	0.8574E 01
I/YIELD STRESS	0.2145E 00

53.00

TEMPERATURE(DEG.FAHR)	84.00
STRAIN A. (MEAS)	1254.00
STRAIN B. (MEAS)	753.00
STRAIN C. (MEAS)	-409.00
STRAIN A. (MECH)	1328.72
STRAIN B. (MECH)	866.72
STRAIN C. (MECH)	-417.28
STRAIN X. (MECH)	44.72
STRAIN Y. (MECH)	866.72
GAMMA XY. (MECH)	1746.00
PRIN.STR.1. (")	1420.63
PRIN.STR.2. (")	-509.19
PHI X (DEGREES)	57.61
SIGMA XX (KSI)	4.91
SIGMA YY (KSI)	11.09
TAU XY (KSI)	6.56
YIELD STRESS (KSI)	39.95
I (KSI)	0.1060E 02
I/YIELD STRESS	0.2652E 00

53.50

TEMPERATURE(DEG.FAHR)	93.00
STRAIN A. (MEAS)	1350.00
STRAIN B. (MEAS)	705.00
STRAIN C. (MEAS)	-397.00
STRAIN A. (MECH)	1427.09
STRAIN B. (MECH)	821.09
STRAIN C. (MECH)	-402.91
STRAIN X. (MECH)	203.09
STRAIN Y. (MECH)	821.09
GAMMA XY. (MECH)	1830.00
PRIN.STR.1. (")	1477.86
PRIN.STR.2. (")	-453.67
PHI X (DEGREES)	54.33
SIGMA XX (KSI)	8.25
SIGMA YY (KSI)	12.89
TAU XY (KSI)	6.86
YIELD STRESS (KSI)	39.89
I (KSI)	0.1218E 02
I/YIELD STRESS	0.3054E 00

GAMMA XY. (MECH)	-90.00	361.00
PRIN.STR.1. (")	609.76	94.43
PRIN.STR.2. (")	-1594.07	-475.48
PHI X (DEGREES)	88.83	70.35
SIGMA XX (KSI)	26.82	36.33
SIGMA YY (KSI)	41.98	39.37
TAU XY (KSI)	-0.31	1.25
YIELD STRESS (KSI)	36.08	36.22
I (KSI)	0.3691E 02	0.3799E 02
I/YIELD STRESS	0.1020E 01	0.1049E 01

54.00	
TEMPERATURE(DEG.FAHR)	105.00
STRAIN A. (MEAS)	1170.00
STRAIN B. (MEAS)	483.00
STRAIN C. (MEAS)	-265.00
STRAIN A. (MECH)	1252.03
STRAIN B. (MECH)	604.03
STRAIN C. (MECH)	-265.97
STRAIN X. (MECH)	382.03
STRAIN Y. (MECH)	604.03
GAMMA XY. (MECH)	1518.00
PRIN.STR.1. (")	1260.10
PRIN.STR.2. (")	-274.04
PHI X (DEGREES)	49.16
SIGMA XX (KSI)	11.75
SIGMA YY (KSI)	13.41
TAU XY (KSI)	5.67
YIELD STRESS (KSI)	39.80
I (KSI)	0.1332E 02
I/YIELD STRESS	0.3346E 00
54.50	
TEMPERATURE(DEG.FAHR)	123.00
STRAIN A. (MEAS)	780.00
STRAIN B. (MEAS)	345.00
STRAIN C. (MEAS)	-145.00
STRAIN A. (MECH)	872.21
STRAIN B. (MECH)	476.21
STRAIN C. (MECH)	-135.79
STRAIN X. (MECH)	260.21
STRAIN Y. (MECH)	476.21
GAMMA XY. (MECH)	1008.00
PRIN.STR.1. (")	883.65
PRIN.STR.2. (")	-147.23
PHI X (DEGREES)	51.05
SIGMA XX (KSI)	13.37
SIGMA YY (KSI)	14.97
TAU XY (KSI)	3.74
YIELD STRESS (KSI)	39.66
I (KSI)	0.1463E 02
I/YIELD STRESS	0.3688E 00
55.00	
TEMPERATURE(DEG.FAHR)	144.00
STRAIN A. (MEAS)	474.00
STRAIN B. (MEAS)	363.00
STRAIN C. (MEAS)	-115.00
STRAIN A. (MECH)	580.45
STRAIN B. (MECH)	508.45

STRAIN C. (MECH)	-91.55
STRAIN X. (MECH)	-19.55
STRAIN Y. (MECH)	508.45
GAMMA XY. (MECH)	672.00
PRIN.STR.1. (M)	671.76
PRIN.STR.2. (M)	-182.86
PHI X (DEGREES)	64.08
SIGMA XX (KSI)	14.41
SIGMA YY (KSI)	18.30
TAU XY (KSI)	2.48
YIELD STRESS (KSI)	39.45
I (KSI)	0.1692E 02
I/YIELD STRESS	0.4289E 00

56.00

TEMPERATURE(DEG.FAHR)	184.00
STRAIN A. (MEAS)	276.00
STRAIN B. (MEAS)	495.00
STRAIN C. (MEAS)	5.00
STRAIN A. (MECH)	409.01
STRAIN B. (MECH)	667.01
STRAIN C. (MECH)	55.01
STRAIN X. (MECH)	-202.99
STRAIN Y. (MECH)	667.01
GAMMA XY. (MECH)	354.00
PRIN.STR.1. (M)	701.64
PRIN.STR.2. (M)	-237.62
PHI X (DEGREES)	78.93
SIGMA XX (KSI)	20.61
SIGMA YY (KSI)	26.53
TAU XY (KSI)	1.29
YIELD STRESS (KSI)	38.94
I (KSI)	0.2447E 02
I/YIELD STRESS	0.6284E 00

57.00

TEMPERATURE(DEG.FAHR)	213.00
STRAIN A. (MEAS)	114.00
STRAIN B. (MEAS)	543.00
STRAIN C. (MEAS)	-7.00
STRAIN A. (MECH)	259.80
STRAIN B. (MECH)	727.80
STRAIN C. (MECH)	55.80
STRAIN X. (MECH)	-412.20
STRAIN Y. (MECH)	727.80
GAMMA XY. (MECH)	204.00
PRIN.STR.1. (M)	736.86
PRIN.STR.2. (M)	-421.25
PHI X (DEGREES)	84.93
SIGMA XX (KSI)	24.02
SIGMA YY (KSI)	32.21
TAU XY (KSI)	0.73

YIELD STRESS (KSI)	38.44
I (KSI)	0.2904E 02
I/YIELD STRESS	0.7554E 00

58.00

TEMPERATURE(DEG.FAHR)	232.00
STRAIN A. (MEAS)	42.00
STRAIN B. (MEAS)	555.00
STRAIN C. (MEAS)	-7.00
STRAIN A. (MECH)	191.05
STRAIN B. (MECH)	743.05
STRAIN C. (MECH)	59.05
STRAIN X. (MECH)	-492.94
STRAIN Y. (MECH)	743.05
GAMMA XY. (MECH)	132.00
PRIN.STR.1. (")	746.57
PRIN.STR.2. (")	-496.46
PHI X (DEGREES)	86.95
SIGMA XX (KSI)	26.75
SIGMA YY (KSI)	35.56
TAU XY (KSI)	0.47
YIELD STRESS (KSI)	38.04
I (KSI)	0.3210E 02
I/YIELD STRESS	0.8438E 00

60.00

TEMPERATURE(DEG.FAHR)	244.00	261.00
STRAIN A. (MEAS)	-526.00	-42.00
STRAIN B. (MEAS)	290.00	579.00
STRAIN C. (MEAS)	-336.00	35.00
STRAIN A. (MECH)	-439.47	101.96
STRAIN B. (MECH)	370.53	761.96
STRAIN C. (MECH)	-295.47	95.96
STRAIN X. (MECH)	-1105.47	-564.04
STRAIN Y. (MECH)	370.53	761.96
GAMMA XY. (MECH)	-144.00	6.00
PRIN.STR.1. (")	374.03	761.97
PRIN.STR.2. (")	-1108.97	-564.04
PHI X (DEGREES)	87.21	89.87
SIGMA XX (KSI)	21.15	31.38
SIGMA YY (KSI)	31.60	40.70
TAU XY (KSI)	-0.51	0.02
YIELD STRESS (KSI)	37.75	37.29
I (KSI)	0.2786E 02	0.3693E 02
I/YIELD STRESS	0.7379E 00	0.9903E 00

65.00

TEMPERATURE(DEG.FAHR)	271.00
STRAIN A. (MEAS)	-300.00
STRAIN B. (MEAS)	369.00

STRAIN C. (MEAS)		227.00
STRAIN A. (MECH)		-160.97
STRAIN B. (MECH)		547.03
STRAIN C. (MECH)		283.03
STRAIN X. (MECH)		-424.97
STRAIN Y. (MECH)		547.03
GAMMA XY. (MECH)		-444.00
PRIN.STR.1. (")		595.33
PRIN.STR.2. (")		-473.27
PHI X (DEGREES)		77.72
SIGMA XX (KSI)		33.89
SIGMA YY (KSI)		40.68
TAU XY (KSI)		-1.55
YIELD STRESS (KSI)		36.99
I (KSI)		0.3769E 02
I/YIELD STRESS		0.1019E 01

70.00

TEMPERATURE(DEG.FAHR)	226.00	266.00
STRAIN A. (MEAS)	-424.00	-450.00
STRAIN B. (MEAS)	218.00	255.00
STRAIN C. (MEAS)	-264.00	311.00
STRAIN A. (MECH)	-337.46	-308.29
STRAIN B. (MECH)	298.54	435.71
STRAIN C. (MECH)	-223.46	369.71
STRAIN X. (MECH)	-859.46	-374.29
STRAIN Y. (MECH)	298.54	435.71
GAMMA XY. (MECH)	-114.00	-678.00
PRIN.STR.1. (")	301.34	558.86
PRIN.STR.2. (")	-862.26	-497.44
PHI X (DEGREES)	87.19	70.03
SIGMA XX (KSI)	20.13	33.14
SIGMA YY (KSI)	28.40	36.81
TAU XY (KSI)	-0.41	-2.37
YIELD STRESS (KSI)	38.17	37.15
I (KSI)	0.2528E 02	0.3621E 02
I/YIELD STRESS	0.6622E 00	0.9749E 00

80.00

TEMPERATURE(DEG.FAHR)		245.00
STRAIN A. (MEAS)		-624.00
STRAIN B. (MEAS)		105.00
STRAIN C. (MEAS)		383.00
STRAIN A. (MECH)		-475.61
STRAIN B. (MECH)		292.39
STRAIN C. (MECH)		448.39
STRAIN X. (MECH)		-319.61
STRAIN Y. (MECH)		292.39
GAMMA XY. (MECH)		-924.00
PRIN.STR.1. (")		540.54
PRIN.STR.2. (")		-567.76
PHI X (DEGREES)		61.76

SIGMA XX (KSI)		29.40
SIGMA YY (KSI)		33.73
TAU XY (KSI)		-3.27
YIELD STRESS (KSI)		37.72
I (KSI)		0.3163E 02
I/YIELD STRESS		0.8385E 00

90.00

TEMPERATURE(DEG.FAHR)		228.00
STRAIN A. (MEAS)		-696.00
STRAIN B. (MEAS)		-9.00
STRAIN C. (MEAS)		401.00
STRAIN A. (MECH)		-547.23
STRAIN B. (MECH)		178.77
STRAIN C. (MECH)		466.77
STRAIN X. (MECH)		-255.23
STRAIN Y. (MECH)		178.77
GAMMA XY. (MECH)		-1014.00
PRIN.STR.1. (")		512.04
PRIN.STR.2. (")		-592.51
PHI X (DEGREES)		56.68
SIGMA XX (KSI)		26.50
SIGMA YY (KSI)		29.63
TAU XY (KSI)		-3.62
YIELD STRESS (KSI)		38.13
I (KSI)		0.2800E 02
I/YIELD STRESS		0.7344E 00

100.00

TEMPERATURE(DEG.FAHR)	196.00	213.00
STRAIN A. (MEAS)	-262.00	-756.00
STRAIN B. (MEAS)	172.00	-99.00
STRAIN C. (MEAS)	-132.00	401.00
STRAIN A. (MECH)	-184.73	-610.20
STRAIN B. (MECH)	193.27	85.80
STRAIN C. (MECH)	-100.73	463.80
STRAIN X. (MECH)	-478.73	-232.20
STRAIN Y. (MECH)	193.27	85.80
GAMMA XY. (MECH)	-84.00	-1074.00
PRIN.STR.1. (")	195.89	486.85
PRIN.STR.2. (")	-481.34	-633.24
PHI X (DEGREES)	86.44	53.25
SIGMA XX (KSI)	19.17	23.66
SIGMA YY (KSI)	23.03	25.94
TAU XY (KSI)	-0.30	-3.86
YIELD STRESS (KSI)	38.75	38.44
I (KSI)	0.2101E 02	0.2465E 02
I/YIELD STRESS	0.5421E 00	0.6412E 00

150.00

TEMPERATURE(DEG.FAHR)		169.00
STRAIN A. (MEAS)		-858.00
STRAIN B. (MEAS)		-405.00
STRAIN C. (MEAS)		305.00
STRAIN A. (MECH)		-734.25
STRAIN B. (MECH)		-242.25
STRAIN C. (MECH)		345.75
STRAIN X. (MECH)		-146.25
STRAIN Y. (MECH)		-242.25
GAMMA XY. (MECH)		-1080.00
PRIN.STR.1. (")		347.88
PRIN.STR.2. (")		-736.38
PHI X (DEGREES)		42.46
SIGMA XX (KSI)		15.06
SIGMA YY (KSI)		14.35
TAU XY (KSI)		-3.95
YIELD STRESS (KSI)		39.16
I (KSI)		0.1431E 02
I/YIELD STRESS		0.3655E 00

200.00

TEMPERATURE(DEG.FAHR)	150.00	145.00
STRAIN A. (MEAS)	-70.00	-876.00
STRAIN B. (MEAS)	50.00	-549.00
STRAIN C. (MEAS)	48.00	275.00
STRAIN A. (MECH)	-21.32	-768.85
STRAIN B. (MECH)	92.68	-402.85
STRAIN C. (MECH)	50.68	299.15
STRAIN X. (MECH)	-63.32	-66.85
STRAIN Y. (MECH)	92.68	-402.85
GAMMA XY. (MECH)	-72.00	-1068.00
PRIN.STR.1. (")	100.59	324.96
PRIN.STR.2. (")	-71.22	-794.65
PHI X (DEGREES)	77.61	36.27
SIGMA XX (KSI)	13.55	10.72
SIGMA YY (KSI)	14.70	8.25
TAU XY (KSI)	-0.26	-3.94
YIELD STRESS (KSI)	39.39	39.44
I (KSI)	0.1413E 02	0.9096E 01
I/YIELD STRESS	0.3587E 00	0.2306E 00

300.00

TEMPERATURE(DEG.FAHR)	129.00	125.00
STRAIN A. (MEAS)	-6.00	-876.00
STRAIN B. (MEAS)	32.00	-651.00
STRAIN C. (MEAS)	78.00	221.00
STRAIN A. (MECH)	[illegible].11	-782.51
STRAIN B. (MECH)	60.11	-518.51
STRAIN C. (MECH)	66.11	231.49
STRAIN X. (MECH)	34.11	-32.51
STRAIN Y. (MECH)	60.11	-518.51
GAMMA XY. (MECH)	-3[illegible].00	-1014.00

PRIN.STR.1. (")	72.13	286.72
PRIN.STR.2. (")	24.00	-837.74
PHI X (DEGREES)	62.10	32.20
SIGMA XX (KSI)	10.46	6.81
SIGMA YY (KSI)	10.65	3.20
TAU XY (KSI)	-0.14	-3.76
YIELD STRESS (KSI)	39.60	39.64
I (KSI)	0.1054E 02	0.4849E 01
I/YIELD STRESS	0.2662E 00	0.1223E 00

600.00

TEMPERATURE(DEG.FAHR)	105.00	105.00
STRAIN A. (MEAS)	2.00	-858.00
STRAIN B. (MEAS)	8.00	-717.00
STRAIN C. (MEAS)	144.00	185.00
STRAIN A. (MECH)	22.03	-775.97
STRAIN B. (MECH)	22.03	-595.97
STRAIN C. (MECH)	118.03	184.03
STRAIN X. (MECH)	119.03	4.03
STRAIN Y. (MECH)	22.03	-595.97
GAMMA XY. (MECH)	-96.00	-960.00
PRIN.STR.1. (")	137.91	270.07
PRIN.STR.2. (")	2.15	-862.01
PHI X (DEGREES)	22.50	29.00
SIGMA XX (KSI)	6.63	3.05
SIGMA YY (KSI)	5.91	-1.43
TAU XY (KSI)	-0.36	-3.58
YIELD STRESS (KSI)	39.80	39.80
I (KSI)	0.6214E 01	0.2226E 01
I/YIELD STRESS	0.1561E 00	0.5592E-01

900.00

TEMPERATURE(DEG.FAHR)	95.00	95.00
STRAIN A. (MEAS)	-4.00	-858.00
STRAIN B. (MEAS)	-4.00	-717.00
STRAIN C. (MEAS)	120.00	173.00
STRAIN A. (MECH)	11.79	-780.21
STRAIN B. (MECH)	5.79	-600.21
STRAIN C. (MECH)	89.79	167.79
STRAIN X. (MECH)	95.79	-12.21
STRAIN Y. (MECH)	5.79	-600.21
GAMMA XY. (MECH)	-78.00	-948.00
PRIN.STR.1. (")	110.34	251.56
PRIN.STR.2. (")	-8.76	-863.99
PHI X (DEGREES)	20.46	29.10
SIGMA XX (KSI)	4.39	0.91
SIGMA YY (KSI)	3.71	-3.50
TAU XY (KSI)	-0.29	-3.55
YIELD STRESS (KSI)	39.88	39.88
I (KSI)	0.3982E 01	0.2359E 01
I/YIELD STRESS	0.9987E-01	0.5916E-01

1200.00		
TEMPERATURE(DEG.FAHR)	89.00	88.00
STRAIN A. (MEAS)	-4.00	-858.00
STRAIN B. (MEAS)	-4.00	-717.00
STRAIN C. (MEAS)	126.00	167.00
STRAIN A. (MECH)	9.88	-782.38
STRAIN B. (MECH)	3.88	-602.38
STRAIN C. (MECH)	93.88	159.62
STRAIN X. (MECH)	99.88	-20.38
STRAIN Y. (MECH)	3.88	-602.38
GAMMA XY. (MECH)	-84.00	-942.00
PRIN.STR.1. (")	115.66	242.26
PRIN.STR.2. (")	-11.90	-865.03
PHI X (DEGREES)	20.59	29.15
SIGMA XX (KSI)	3.27	-0.55
SIGMA YY (KSI)	2.55	-4.92
TAU XY (KSI)	-0.32	-3.53
YIELD STRESS (KSI)	39.92	39.93
I (KSI)	0.2808E 01	0.3343E 01
I/YIELD STRESS	0.7035E-01	0.8374E-01
1800.00		
TEMPERATURE(DEG.FAHR)	86.00	83.00
STRAIN A. (MEAS)	-16.00	-952.00
STRAIN B. (MEAS)	2.00	-729.00
STRAIN C. (MEAS)	138.00	161.00
STRAIN A. (MECH)	-2.86	-777.46
STRAIN B. (MECH)	9.14	-615.46
STRAIN C. (MECH)	105.14	152.54
STRAIN X. (MECH)	93.14	-9.46
STRAIN Y. (MECH)	9.14	-615.46
GAMMA XY. (MECH)	-108.00	-930.00
PRIN.STR.1. (")	119.55	242.54
PRIN.STR.2. (")	-17.27	-867.47
PHI X (DEGREES)	26.06	28.46
SIGMA XX (KSI)	2.63	-1.45
SIGMA YY (KSI)	2.00	-6.00
TAU XY (KSI)	-0.41	-3.49
YIELD STRESS (KSI)	39.94	39.96
I (KSI)	0.2107E 01	0.4352E 01
I/YIELD STRESS	0.5276E-01	0.1089E 00

CORE USAGE OBJECT CODE= 9680 BYTES,ARRAY AREA= 6468 BYTES,TOTAL AREA AVAILABLE= 26720 BYTES

COMPILE TIME= 0.37 SEC,EXECUTION TIME= 0.86 SEC, WATFIV - VERSION 1 LEVEL 2 AUGUST 1970 DATE= 73/121

TEST NO. 5 (CONTINUED): 3.00 INCH TRANSVERSE DISTANCE FROM THE CENTERLINE AT CENTER OF PLATE:

Time (Seconds)	Temperature (^{o}F)	ϵ_x (Measured) (Microstrain)	ϵ_y (Measured) (Microstrain)	ϵ_x (Mechanical) (Microstrain)	ϵ_y (Mechanical) (Microstrain)
0.00	78.00	-39.00	21.00	-32.83	27.17
10.00	78.00	-80.00	6.00	-34.83	- 8.83
15.00	78.00	-85.00	-24.00	-39.83	-38.83
20.00	78.00	-25.00	-89.00	20.17	-103.83
25.00	78.00	125.00	-39.00	170.17	-53.83
26.00	78.00	155.00	76.00	200.17	61.17
27.00	78.00	155.00	116.00	200.17	101.17
28.00	80.00	190.00	116.00	235.00	101.00
30.00	80.00	270.00	51.00	315.00	36.00
32.00	87.00	395.00	-34.00	439.94	-49.06
35.00	101.00	410.00	-89.00	456.94	-102.06
40.00	127.00	155.00	-84.00	211.20	-87.00
45.00	144.00	-90.00	-34.00	-25.48	-29.48
50.00	152.00	-260.00	16.00	-191.31	24.69
60.00	166.00	-425.00	61.00	-349.06	76.94

Time (Seconds)	Temperature (^{o}F)	$x^{(Measured)}$ (Microstrain)	$y^{(Measured)}$ (Microstrain)	$x^{(Mechanical)}$ (Microstrain)	$y^{(Mechanical)}$ (Microstrain)
75.00	169.00	-475.00	91.00	-397.55	108.45
100.00	167.00	-430.00	96.00	-353.55	112.45
200.00	143.00	-220.00	96.00	-155.99	100.01
300.00	127.00	-150.00	96.00	-93.80	92.20
600.00	104.00	-100.00	91.00	-52.31	78.69
900.00	94.00	-85.00	81.00	-39.39	66.61
1200.00	89.00	-70.00	81.00	-24.94	66.06
1800.00	85.00	-70.00	76.00	-25.12	60.88

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